AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL 11, No. 49. WEEKLY. | NEW YORK, DECEMBER 8, 1888. | $2.50 per Annum. SINGLE COPIES 5 CENTS.

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The Armstrong Engine.

We illustrate herewith the "Armstrong" engine, manufactured by the Weston Engine Co., Painted Post, N. Y., in sizes up to 60 horse-power. This engine belongs to the somewhat numerous family of single-valve automatics, but, as will be seen, possesses some features peculiar to itself.

The valve used is a flat, balanced slide, working between its seat and a heavy pressure plate. The steam is brought to the center of the valve in what is usually the exhaust port, and is admitted to the cylinder through four openings at once. As the length of each is equal to the diameter of the cylinder, and as the movement of the valve is very large, it gives, as might be expected, a high steam line and sharp cut-off for this style of engine. This arrangement gives opportunity to open the steam chest and inspect the valve under pressure. Provision is made whereby any wear may be taken up and the valve kept in good condition. This adjustment, however, need only be made at long intervals.

The valve is actuated by the usual shaft governor, which is, in this case, of simple construction, consisting of the eccentric, two fly weight castings, a single flat spring and half a dozen pins and bolts for connecting the parts together. All strains are in the same direction, regardless of the position of the governor, thus preventing any lost motion from wear. There is claimed to be no difficulty in adjusting the governor to a variation in speed considerably less than one per cent., light or loaded, though the makers recommend, where it is admissible, a somewhat greater range—say one and one-half or two per cent., as giving greater stability and less wear.

The oiling devices are very complete, every wearing part being oiled from stationary sight-feed oil cups, and also capable of being oiled from a common oil can, while in full motion. The oil wasting from the crank boxes is caught and carried to the crank-pin and eccentric. Oil flying from the crank is caught in suitable oil-boxes, and held until the engine stops. The crosshead is new, and possesses the important feature of going together in correct alignment.

The stuffing-boxes of small engines are usually the source of considerable trouble, which is believed to be reduced to a minimum in this engine. The valve stem being carried in a straight line, and having to be packed only against exhaust steam, is not liable to leak after being once properly packed. The piston-rod stuffing-box is of peculiar construction, and does not ordinarily, it is said, need attention oftener than once in six months; in one case, having been run for over a year without leakage, and without even tightening up, as the construction of the stuffing-box does not permit of adjustment. It is believed that these results are much superior to usual practice of fibrous packing.

The bearings are generous enough to satisfy the most radical advocate of large wearing surfaces. They are finely fitted, and proved in the testing room by being run at high speed and heavily loaded, until they will work to double their rated power without showing any tendency to heat or pound.

The sectional cut shows the arrangement and construction of the cylinder, piston, steam chest, and valve, and we also publish (page 2), two diagrams which show the behavior of the steam in the cylinder at two different points of cut off; the back pressure results from exhausting through heating coils.

Force in the Steam Engine and its Relation to Smooth Running.

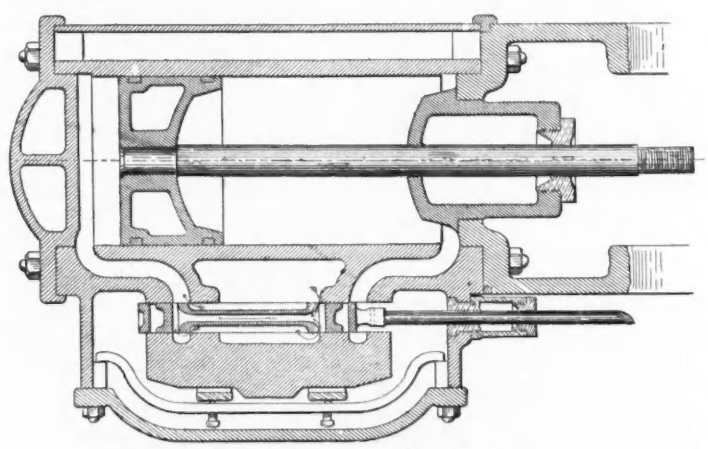
SIXTH PAPER.

BY PROF. JOSEPH TORREY.

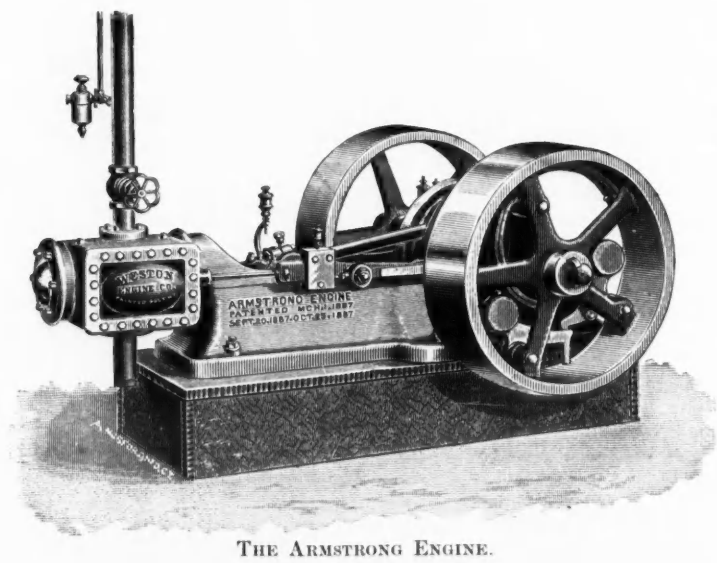
We have seen that, as engines are built, the crank motion can be regarded as uniform. It is evident on the most casual glance that the piston motion very *near the ends* of the stroke is much slower than the crank motion, and that, when the crank is exactly at mid-throw, the piston and crank-pin move for an instant *at precisely the same velocity*; but we have learned previously that the piston, by reason of the connecting-rod action, attains its *greatest* velocity on the forward stroke before reaching the middle of its stroke, and quite a little before the crank reaches its mid-throw point. Therefore, there must be a point between the beginning and middle of the forward stroke, where the piston actually moves faster along the guides than the crank-pin does in its regular circular path. This may seem strange, but it is due to the fact that the piston velocity results from two distinct tendencies of the crank-pin, one of which is an *upward* tendency, and the other a horizontal tendency; that is, parallel to the guides.

Remembering this, it will be instructive to trace briefly the operation of these two tendencies throughout an entire revolution of the crank-pin in its path. In Fig. 1, page 2, the circle represents the path of the center line of crank-pin, and A B represents the piston stroke.

Starting at the beginning of the forward stroke, from A to B, suppose the crank end of the connecting rod to be lifted from F to E perpendicularly, then setting a pair of compasses to the length of connecting rod (= 3 times length of stroke), and marking an arc n n', we have the amount of motion imparted to the piston by the *upward motion alone* of the connecting rod. Let, now, the end of the rod be carried along the line E D to D. On setting the point at D, and marking an arc h h', it is seen that the piston will have moved the same distance, although the pin had moved from F to D on the circle. It is also seen that the total amount of piston motion is equal to the line D E + the amount of movement imparted to the piston by the upward movement F E. During the latter half of the stroke the horizontal motion is identical in amount, but the vertical movement down from I to G, instead of quickening the piston motion, acts in the opposite way. The same is true in the first half of the backward stroke; but on the last half, the vertical element again acts to quicken or accelerate the piston motion. It follows that the piston velocity will vary with the effect of these two combined tendencies developed by the crank motion. It will easily be seen, too, that the longer the connecting rod, the less the effect of the vertical movement, so that when the connecting rod was of infinite length, it would be nothing at all, and the amount of movement communicated to the piston during half a stroke would be equivalent to the horizontal movement of the crank alone.



SECTION THROUGH CYLINDER.



THE ARMSTRONG ENGINE.

Now, to find the velocity of the piston relatively to that of the crank motion, we can follow one of two methods. There is first a simple method which involves only drawing and measuring. Then there is a way of figuring it out which is somewhat more accurate. I will give these two methods briefly.

First, however, it is well to notice that if we solve the problem for ten points or so in the piston stroke of any engine with connecting rod = 6 cranks, our results will be true for any engine in which the rod bears the same relation to the crank; so let us set ourselves *to find the velocity of the piston relatively to that of the crank-pin at each of nine points in the piston stroke, besides the beginning and end, for an engine whose connecting rod = 6 cranks.*

Draw a circle B E, with radius of $\frac{100}{32}$". This will be $3\frac{1}{8}$". This length of radius is taken because it will give the results more directly. Taking now a radius equal to $18\frac{6}{8}$" (= 6 cranks), mark from B the point C, and from F the point A. These will be the ends of the stroke. Divide A C into 10 equal parts. Then, taking the connecting-rod radius again, mark arcs from each point crossing the circumference, then proceed to find the piston velocity at each point, as follows: In case, for instance, of the point K, draw from K a line passing through the arc K', which was struck from that point, and carry the line along till it cuts the perpendicular X Y at H. Carefully measure the length of O H in thirty seconds of an inch, and this will give the velocity of the piston when it is at point K, the crank-pin velocity being considered as 1 foot per second. Suppose, for instance, the distance O H turned out to be $\frac{84}{32}$"; then the piston velocity would be $\frac{84}{100}$" of the crank-pin velocity at the point K. That is, if the crank-pin was traveling 100' per second, the piston would be traveling at the rate of 84' per second.

To calculate the same thing mathematically, we note that the piston velocity increases directly as the sine of the sum of the crank angle and the connecting-rod angle, and inversely as the cosine of the connecting-rod angle.

To calculate the velocity of piston at any point, first proceed just as before, and draw the same lines. Then measure the angles H K O and D O F. Add them together, and if they are more than 90° together, subtract their sum from 180°. Find, in a table of natural sines, tangents, etc., such as can be found in any good engineer's pocketbook, like Trautwine's or Haswell's, the sine of this sum (or 90° — this sum, as the case may be), and divide this sine by the natural cosine of the connecting-rod angle. The result will be the velocity of the piston relatively to that of the crank-pin.

The results will be very accurate in the first method, and will be found to agree very closely with those obtained by the second method. I give below a table which was calculated by both methods. The results will be seen to agree quite closely. The exact velocity, in feet per second, of the piston, can be found for any engine in which connecting rod = 6 cranks, by multiplying the numbers in the table by the crank-pin velocity

in feet per second, which can be easily figured from the stroke and number of revolutions per minute. For example, suppose the engine has 10″ stroke, and makes 300 R. P. M. The crank-pin center travels in a circle whose circumference is 10×3.1416, or 31.416″. This is equal to 2.618 feet. The crank-pin makes 300 R. P. M., and, consequently, travels 300×2.618, or 785.4 feet per minute, or 13.09 feet per second.

Multiplying the figures in the table by 13.09 will give the actual velocities, in feet per second, of the piston at each of 9 points in the stroke. At beginning and end of stroke the piston velocity is, of course, 0.

It is an easy matter, if desired, to calculate a similar table for any different relation between crank and connecting rod; all that is necessary is to draw a figure like Fig. 2, to scale. The same diameter can be used for convenience, but the radius taken with which to strike the arcs on the circumference must be longer or shorter than 6 cranks, to correspond with the engine under consideration.

This, then, gives us the element of velocity. The next question is as to the *time* occupied by the piston in passing over each of the ten equal divisions of the stroke. Referring to Fig. 3, and remembering again that the crank movement is regarded as uniform, it will be seen that, if we know how long the crank takes for one revolution, it will take half that time for half a revolution, one-third for one-third of a revolution, etc. Suppose, then, we wish to find how long it takes to pass from 1 to 2, or over the division 1, 2.

This piston division is evidently passed over while the crank-pin passes from 1′ to 2′. Now, suppose the crank makes 1 revolution per second, for convenience. Then the crank-pin moves through 360°, or the whole circumference, in one second. Referring to the table, it is seen that the crank angle passed through during the piston division 1, 2, is 34°; then to pass over this space will require $\frac{34}{360}$ seconds. If the crank-pin made *two* revolutions per second, the crank would travel 720° in one second, and the space 1′, 2′ would be passed in $\frac{34}{720}$ seconds. If *three*, then $\frac{34}{1080}$ seconds, etc.

If the crank angle contains *minutes*, *e. g.*, 34° 20′, the minutes can be reduced to decimals of a degree by dividing by 60; thus, 20 minutes would equal $\frac{20}{60} = 0.333+$ seconds, and the angle would be written 34.333°.

We have now got our *time* and *velocity* questions settled, I hope, clearly. Next time we will apply them to the calculation of the inertia force developed during each of the ten divisions of the stroke.

In this table, stroke = 1 foot; rev. per min. = 60; connecting rod = 6 cranks. To find the piston velocity for any engine, multiply the numbers in the 3d or 4th columns by the crank-pin velocity in feet per second.

Ordinate.	Connecting-Rod Angle.	Crank Angle.	Piston Velocity Measured.	Piston Velocity Calculated.	Ordinate.
0	0°	0°	0	0	0
1	5°30′	34°	0.640	0.639	1
2	7°30′	50°	0.847	0.850	2
3	8°40′	62°	0.952	0.954	3
4	9°30′	73°50′	1.006	1.007	4
5	9°50′	85°	1.012	1.011	5
6	9°20′	96°30′	0.975	0.975	6
7	9°	109°	0.893	0.894	7
8	8°	122°40′	0.765	0.765	8
9	6°	140°	0.558	0.559	9
10	0°	180°	0	0	10

Practical Details of Blacksmithing.

By B. F. Spalding.

ADVANTAGES OF MACHINERY — WELDING BUGGY AXLES—WELDING TIRE BY MACHINERY—MACHINES FOR SHRINKING ON COLD TIRE—WELDABLE STEEL—WELDING STEEL TIRE—TIRE-HEATING FURNACES—INSPECTION OF WORK.

The energy of a driver may be required to get the necessary power out of an apathetic, insensate mule to do a certain piece of work, and it will probably be easier to procure a man who will willingly furnish a great amount of energy to drive the mule, than to get one who will incessantly supply the much smaller amount which it might require to do the work himself. It may be laid down as a general proposition that more work can be finished in a specified time by the use of machinery, driven by extraneous power, than will be accomplished with the use of that which is propelled by the muscular force of the operator. This may still be true, even if each distinct operation in the one case can be performed in the same length of time that it is in the other. That is to say, for instance, a man will strike more blows in a day with a drop propelled by steam power than with one which he pulls up himself, although he may be able to strike quicker blows with the hand-drop than with the other. This proposition is so evidently correct that it would scarcely be worthy of remark, if it were not for the fact that its very palpable truth, with the lesson it carries, is often lost sight of, or not accorded due consideration, in devising ways and means of doing work.

An instance, which may be cited as one in which due advantage is taken of this fact, is the welding of buggy axles under the trip-hammer. It is possible that two good, smart men can weld as many buggy axles together in a day, without a trip-hammer, as with one, although at the expenditure of a much greater degree of muscular energy.

The stub ends of the journals having been left long enough to make an axle by welding two of them together, the operations of welding buggy axles, as carried on in a manufactory doing a great amount of this work, are as follows: Each end is heated and cut by gauge to a certain length with a cutter, in the trip-hammer. This starts the scarf by knocking back the stock on the lower side of the cut, and it is finished on another part of the die, the upper die overlapping the under one, to keep the top of the scarf straight. The pieces are now boraxed, and welding heats are taken, when the helper, taking one of them out, lays it on the lower die of the trip-hammer, in such a way that about half of the scarf lays over the die on the blacksmith's side; the blacksmith lays the other piece on this and the trip-hammer, being started at once, welds that end of the scarf, and the axle being at once turned over, and shoved on the die, the other end is immediately welded; the thin edges of the scarfs not having come in contact with a cold surface, except at the instant the impact of the blow was felt. The axle is now gauged for length, and drawn until its dimensions, in this respect, are correct, after which it still retains sufficient heat, and is readily bent over the "former," which gives it the shape in which it is required to be finished.

No one of the operations performed on the axle with the trip-hammer can be done much, if any quicker, with that tool, than it could be by hand. The one in which the most stock is disturbed is the scarfing, and of this it may be said that it is not a hard job to scarf soft steel as light as buggy axles. In an establishment working eight hours per day, with the men in the habit of working under the stimulus of piece-work, it would not be surprising if two men, doing this work by hand, should, on a wager, accomplish more than another couple using the trip-hammer.

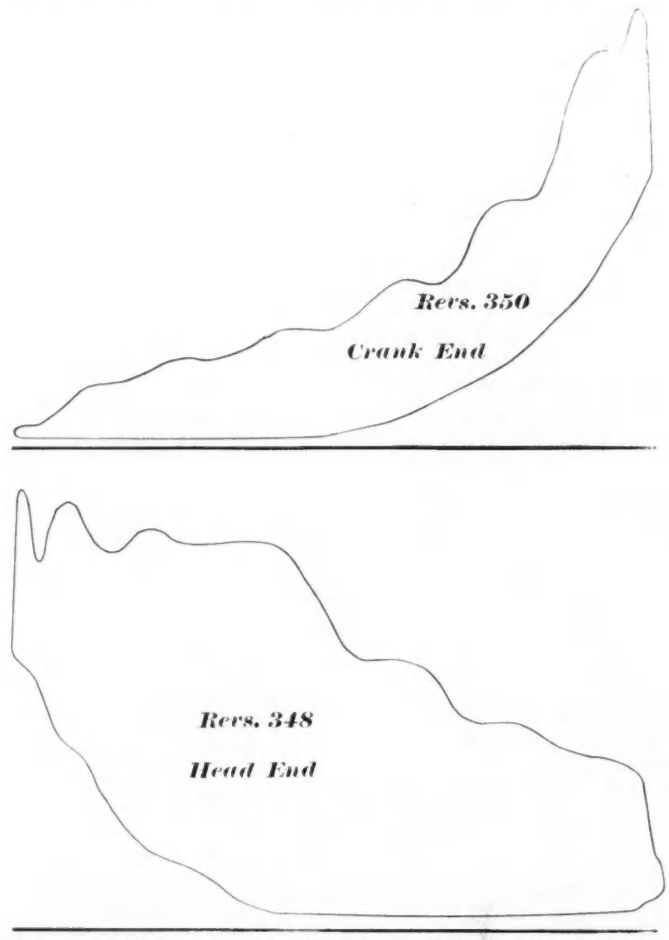
The question then arises, where is the advantage of using machinery on such work? This is answered by an examination of facts, which show that, as a rule, a greater number of pieces will be made, day after day, by easy, than by fatiguing processes, although the harder way may be full as expeditious.

There is a vanishing point in this matter. It is a fact that there are many instances on record where large expenditures have been made to do work by machinery, which, in the small advantages gained, have not realized, for the outlay, anything like adequate compensation. In cases where the machinery has but a very small part of the work to do, and must lay still a large portion of the time, and the helper either has nothing to do while the machinery is working, or is employed in attending the machine when he might, with as little fatigue, do the work himself, there is no question as to the economy.

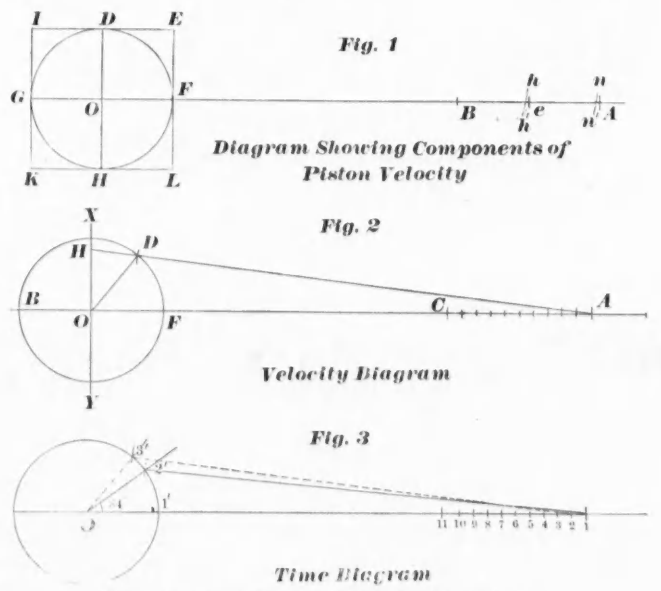
This limit is very nearly reached in welding light tires for cheap wheels, under the trip-hammer. These tires are welded, in agricultural machine shops, by thousands, for such things as cultivators, rakes, drills, tedders, and other light farming machinery. When they are less than three-eighths of an inch they are generally welded without scarfing. As, with proper attention to the making and inspection of the rims, the wheels will come of nearly uniform size, it is only necessary to run a few with the tram wheel, to get at a proper length to cut the bars. These are punched for the bolt-holes, and cut off to the required length at the punching and shearing machine, and afterwards straightened on the edge, and run through the rolls to bend them. The blacksmith then takes the heats on the ends, and when they are hot he brings it to the anvil; the helper now holds one end on the anvil, and in an instant the blacksmith comes on with the other end, laying it on the first a distance about equal to the thickness of the iron, and, if very light, welds it himself with his hand-hammer; or, if a little heavier, his helper strikes a few blows with his light sledge, and as soon as its size at the weld is uniform with the rest of the stock, it is set off to one side as completed. Another set of men may now take it in hand, and "set" it on the wheel.

The use of tire-shrinking machines renders any great particularity about getting exact lengths entirely unnecessary. The tire may be, and frequently is, so much larger than the wheel to which it is to be shrunk, that a man can thrust his whole hand through the space between the two, but when subjected—and that too without heating—to the boa constrictor action of the flexible steel spring which surrounds and draws it together in one of the tire-shrinking machines, it is contracted in a manner which excites surprise in every one who beholds it for the first time, and never-ceasing admiration from those to whom its efficient action has long lost the charm of novelty. As the steel spring draws tighter and tighter the wheel bows up, or "dishes" somewhat in the middle. The amount of this bowing is determined by a set gauge, and when that is reached the constriction is relaxed, and the "dish" goes down to some extent, leaving, however, enough strain upon the spokes to keep the rims tight, out against the tire.

The tire is welded in some establishments with the trip-hammer, and in some others with a "welding machine," and the operations are similar to those of hand welding, until it comes to taking the heats for welding, when the difference consists in taking it from the fire before the welding heat is attained, punching a hole in each end, and riveting the two ends together. The welding heat may then be taken in a forge fire, or in an anthracite furnace, the cap of which is fastened at one end, leaving the other end open, so that the tire can be passed in under it; the latter method is preferred. There is a fine field on this work for fuel gas, petroleum, or electricity. When the



Indicator Diagrams from Armstrong Engine.—See Page 1.



Force in the Steam Engine.—See Page 1.

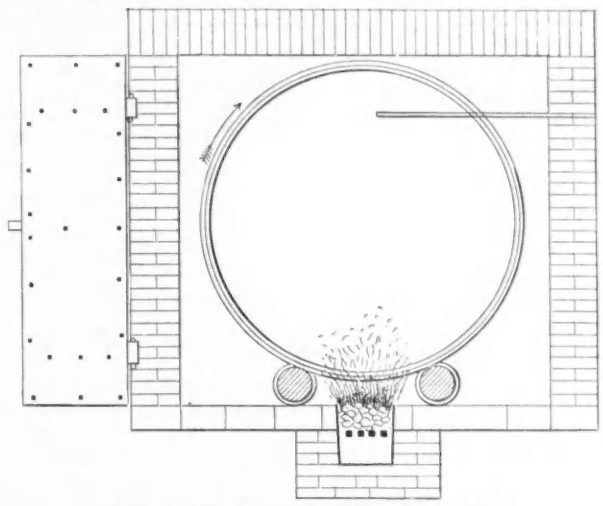
tire is hot enough to weld, it is placed in an impression in a trip-hammer die, which is of the proper size and depth, and sufficiently flaring to obviate any danger of its getting stuck, the hammer descends, the tire is moved along in the die, and the place where it is welded is reduced to the uniform size. The welding machine welds 1¼ x ¼ steel tire at one blow. There may be a slight fin, but this is at once removed with a stroke of a coarse file.

As by this method the stock is more closely confined, it would appear as though the quality of work would be better by this than by the other method. There is practically, however, no trouble with the other method, and therefore this superior excellence is superfluous. The welds of the trip-hammer are probably the strongest; in neither is the tire as strong as it is elsewhere. The theory is, that it is not necessary that it should be, as long as the strength of the weld is on the inner side. It is taken as granted, that it is only necessary that the strength of the weld shall be equal to the strength of the tire when that shall have been worn down to the limit of its durability. This theory holds that a band of hoop iron, an eighth of an inch in thickness, would probably hold all the outward pressing strain, and that the excess of stock over this amount is to withstand wear, and the shock of blows and pressure against the outer part of the arcs of the circle.

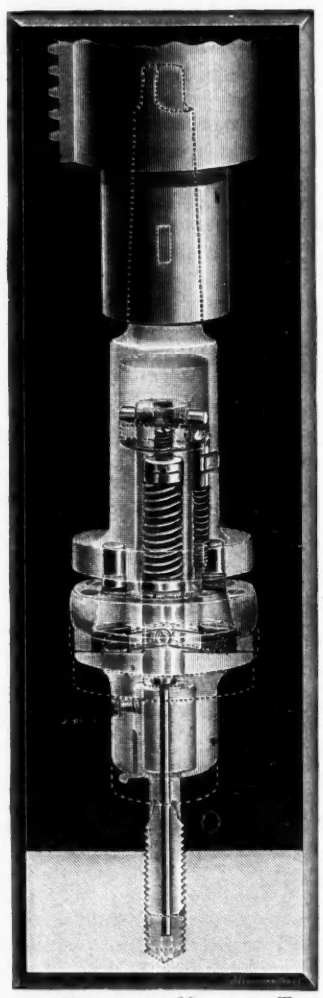
In welding the tires for the wheels of conveyances, much more regard is paid to the excellence of the workmanship, because in these the wheels are really the principal, instead of the auxiliary parts of the construction, and as such are closely inspected by those who propose to invest their money in them. The tires are therefore scarfed to obtain good, smooth-looking welds, because it is better for the makers to have a little time spent in doing this, than to hold profitless discussions with cautious customers about bad looking welds.

When at the present time we enter a carriage manufactory where steel is used for tires, and witness the constant and continuous welding of one after another without interruption or deviation from regular routine, we can hardly realize that it is only a few years ago, when it was thought to be quite a feat to weld and put on steel tire. It is not more than twenty-five years ago, that a New England manufacturer of steel tools related to me, as a curious circumstance, that a noted carriage smith of our acquaintance had been given a job at the government establishment where he was employed, of welding a set of steel buggy tires for the superintendent, and only succeeded in doing it after repeated failures. The explanation was simple. The steel was high tool steel and not easily welded, and although he riveted the ends, the jar of the second blow undid the welding of the first. He was successful when his helper bore down steadily on the tire, while he stuck the inner lap first, and then, moving it further on his anvil, welded the outer one.

The causes which produced failure in welding steel tire twenty-five years ago do not now exist. If the steel comes from the makers, of an unweldable nature, which ten years ago was sometimes the case, but is rarely so now, it is sent back. It is furnished to the shops in bundles containing stock for a full set of tires, two long and two short bars; and at one time, so little was it to be depended upon for uniformity, that three of the bars would weld without trouble, while the fourth was so high that nothing could be done with it. This is all changed now, in establishments which have had continual dealing with the steel makers, until both parties have come to understand what is required. The steel tires are now welded with as little risk as iron. The tires are bent before they are measured, as it is most convenient to handle them in this shape. Each wheel is run with the tram-wheel, and a tire cut off for it, and from this time until the tire is shrunk on, care is taken to keep them associated together. The tires are heated and scarfed, and being lapped together as they belong, a punch is driven into the scarf far enough so that the punching started out serves to hold them in place while taking the welding heat. The heat is well taken in a common forge fire, which has the draft hole into the chimney very low down. The advantage of this arrangement is, that the fire is switched off up the flue before it heats so much of the tire as to make it inconvenient to handle. Borax is used as a flux. The helper assists with a few blows in the welding.



Section of Tire Heating Furnace.



DRIVING HEAD FOR MACHINE TAPPING.

The tires are heated in a furnace, a dozen at a time, for shrinking on. An excellent furnace for this purpose, simple, efficient and economical, is one which has a door at one end, through which the tires are easily entered. Parallel with the door is a narrow fire, which reaches across the width of the furnace in the center of the floor. On each side of this is a continuously revolving grooved roll. A tire, set in a groove on top of these rolls, slowly revolves over the fire, and is kept perpendicular by pins which steady it on either side. It stands like a horse in a stall. On Harrison avenue, Boston, in 1863, there was a tire-heating furnace which was heated by gas jets burning all around the upright tire. Constant practice at this particular branch of the business gives the workmen great skill in setting the tires on the wheels, and their work is afterwards, and before it leaves the shop, submitted to the examination of careful and judicious inspectors, and for any bad defects is rejected. It is an adage in shops where the same men do the same work over and over, until they become thoroughly familiar with it, that "it is just as easy to do a job right as wrong." Only such jobs as are right are allowed to pass. In large establishments, where such regulations prevail, it is evident that the workmanship must generally be good. Small establishments have perhaps some advantage in culling choice stock outside of the regular markets.

Driving Head for Machine Tapping.

We illustrate herewith a driving head for machine tapping, made by the Hampden Tool Co., Holyoke., Mass. The tool is made in one size only, having a range from ¼ inch to 1¼ inches inclusive, without any adjustment being required.

Ordinarily this attachment will be used in an upright drill or screw machine, which has right and left belts for going ahead or reversing at will. In operating, the upper member is lowered until its driving lugs come in contact with those of the lower members, which are on a clutch ring driven by being thrust into its taper seat by two wedges, actuated by a toggle-joint operated by a spring, as shown in the cut. The tap, with its spindle projecting top and bottom, is held in the attachment by a spring gib, allowing an easy change from one size to another; as the bottom of the hole is approached, the top spindle moves up, taking with it the guiding bar for the toggle-joint, thus drawing in the wedges, allowing clutch rings to drop off its seat and pass around, freely permitting the lower member to come to rest while the machine still goes ahead. The driving clutch is now thrown out by virtue of the tap spindle being on the bottom of hole. In reversing, raise up the crosshead of drill or other machines until the pin, passing through the shank of the lower member, drops to its seat in the chamber of the upper member and comes in contact with the side reversing pin; the machine having been reversed, the tap is withdrawn from the hole.

The spring made side-reversing pin acts as a safety device when the revolving machine is not reversed on the crosshead being raised, thus taking the pin on back side, and pushing it down out of the way.

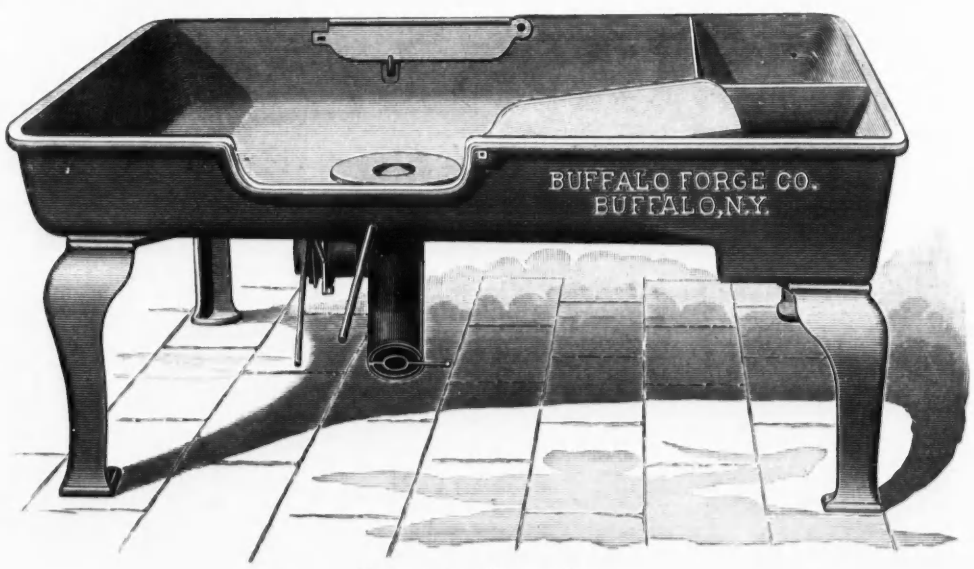
Full lines in the cut show the driving position of details, and dotted lines show the tripping position at the bottom of the hole.

Stationary Blast Forge.

The accompanying cut illustrates a new stationary blast smith's forge, which was especially designed for the Burton Car Co., Wichita, Kas., to meet their requirements for extra heavy work. It has a large deep fire-pan, 62x48 by 10 inches deep, with fire-pit 4 inches lower still, giving a depth of 14 inches from the top of tuyere plate to the bottom of fire-pit. This makes it especially adaptable to handling large and heavy work. For light work the gates on side can be opened and fire lowered 4 inches.

The tuyere iron is extra heavy, with 3½" blast gate, fitted with an improved anti-clinker triangular ball for regulating the blast, and is designed especially to withstand heavy service without burning out. The water and coal boxes are cast in one piece with the fire-pan, with a sloping partition dividing the two, for easy removal of coal.

The manufacturers of these forges are the Buffalo Forge Co., Buffalo, N. Y.



STATIONARY BLAST FORGE.

An Electrical Fire Engine.

About the most recent invention for the application of electricity is Prof. Wheeler's electrical fire engine. It is intended to be worked by the current of any of the overhead electric light wires. The principal difference in the invention to the ordinary steam fire engine is that the power is obtained from a motor instead of the steam chest. Each of the new engines will carry a reel of some 500 feet of insulated fine copper wires, bound together cable fashion, so as to equal in strength a No. 3 wire for the transmission of the current. As by this method the engine can be placed anywhere, as the wires overhead can be tapped anywhere, the engine will be placed nearer the fire than by the old method. The powerful current of an arc light wire will not be required, that of the ordinary incandescent circuit being of sufficient potential to run the motor.

The advantages claimed for this new method are many. In the first place it is much lighter, and much greater speed can therefore be attained. Again, owing to the construction, it can be built for about one-third of the cost of an ordinary steam fire engine. A very important consideration is that, like all motors, it starts up immediately under full speed. It is safer and easier of control. It is noiseless, and is much more economical. That this last point is true is perfectly evident. The expense for fuel for the present engine in use is considerable. By tapping the wires overhead, fuel is provided gratis. The above advantages are claimed by the inventor, and many of them seem important, and, if the claims can be substantiated, the invention will soon be in universal use.—*The Commercial Bulletin.*

Manufacturing Names and Symbols.

By Oberlin Smith.

SECOND PAPER.

Another symbol (to mention a fourth improvement) has been recently adopted by the writer to designate each particular *special tool* forming part of a set used for a given operation. It is a simple letter A for the first tool used, B for the second, etc., and is known by its position at the end of the "string" of symbols which precede it—each symbol being separated from its neighbors by a hyphen, and being in logical sequence as above described. Thus an operation may begin by placing the piece under treatment in a jig marked "A." Perhaps a bushing must then be inserted somewhere, which may be marked "B." A special boring tool, marked "C," is perhaps then brought into action; then a counter-boring tool marked "D"; then perhaps some auxiliary jig must be applied, which before would have been in the way, and this would be marked "E"; the boring tool then used, "F," etc. Thus, with the proper "string" of symbols, consisting only of a few figures, letters and hyphens, all following each other in a straight line, and brief enough to be stamped upon an extremely small surface, any special-tool may be absolutely distinguished from every other one, and from every obsolete tool which preceded it in the same operation when the piece it was used on was of a somewhat different form, and had a different "style letter."

The symbol names of every *article*, every *piece* (with its style indicating the number of its obsolete predecessors), every *operation* on the same, and every *special-tool* needed for such operation, are thus, in simplicity, reduced to their lowest terms, so to speak, and follow a logical law which is applicable to the manufacturing of all kinds of machines and a great many other articles, without danger of confusion one with another, even in the largest factories, and during a life of any number of years. The evolution of a few of these symbols is best shown by the examples in the table below.

Class of Symbol.	Descriptive Name.—*For Circulars, Verbal and Written Descriptions, etc.*	Commercial Name.—*For Price-lists, Estimates, Orders, etc.*	Symbol Name.—*For Manufacturing—in Office, Drafting-room and Shop.*
Article	18″x6′ Gibbed-rest Screw-cutting Engine Lathe	Lathe 6DL	6DL
Piece	Tail-stock Wheel	75–6DL–7B	6DL–7B
Operation	Drilling Handle hole	.....	6DL–7B–14
Tool	Drilling Jig	.....	6DL–7B–14–A
Article	Sel.-raking and Binding Four-horse Reaper	Reaper 5R	5R
Piece	Reel-shaft Ferrule	5R-325A	5R–325A
Operation	Punching Side Hole	.....	5R–325A–13
Tool	Horn Die	.....	5R–325A–13–A
Tool	Punch	.....	5R–325A–13–B
Article	Seven chambered Self-cocking Revolver	Pistol DP	DP
Piece	Barrel	9876–DP–2H	DP–2H
Operation	Reaming	.....	DP–2H–15
Tool	Last Reamer	.....	DP–2H–15–B
Article	Parlor Coal Stove with 8″ Cylinder	Stove 2PC	2PC
Piece	Base	2PC–1D	2PC–1D
Operation	Moulding	.....	2PC–1D–6
Tool	Follow-board	.....	2PC–1D–6–C

In the first specimen of the table, regarding a certain lathe, the scheme supposed for arranging the article-symbol is to use the initial letter "L" for all lathes made by the concern; then, in this particular pattern, the letter "D" for the 18″ size—"C" standing for the 15″, and "B" for the 12″, which is the smallest they now propose to make—"A" being reserved for a possible 9″, should such be produced in the future. The first figure, "6," refers to the length of bed in feet, and in some cases might consist of two figures, as in the event of a lathe 12 feet long, etc. Such a scheme as this especially suits machines which are variable in one important dimension, while all other sizes remain the same, as in variable bed lathes, planers, etc. (In such a lathe it frequently happens that only two pieces are altered viz., the bed and screw. This makes it desirable that the several hundred other pieces should keep their piece-symbols.) If thought best, the number might be put in the middle and a letter at the beginning of the symbol, as "D 6 L." Thus a set of variable bed planers might be "A 4 P" and "A 5 P" for the smallest size, where the beds were four and five feet long respectively, while "D 10 P" might represent one with a 10-foot bed, and of the fourth size in regard to width and height. In the second line of this first specimen in the table we have the piece-symbol for commercial use, preceded by the *shop-number*, assumed to be "75." The tail-stock wheel mentioned is supposed to be the seventh piece in the series of piece numbers, and to have been altered once, thus being known as "7 B." In the third line is shown an operation upon it, numbered "14"—the preceding ones of boring, turning and key-seating having been numbered 11, 12 and 13 respectively. In the fourth line the jig to be used is marked "A," as it is the first special-tool that would have to be used for drilling this particular hole.

The second specimen given will mostly explain itself. In this case the article-symbol has been given but two characters, because one concern is not supposed to build a great many distinct types and kinds of reapers. "R" is taken as suggestive of the word "reaper," the number "5," preceding it, showing that it is the 5th pattern made. This class of machines are frequently remodeled somewhat each year. Therefore a new number would be used for each year's style or pattern, and the letter "R" would be retained indefinitely. If in this class of goods it should be considered desirable to omit shop numbering, the article-symbol (prefixing the piece-symbol) would probably be sufficient to refer to in ordering duplicate pieces, as where a thing is remodeled every year or two and built up in very large batches, ready for a season's use, it is not likely that any changes would be made in the design until the next pattern is gotten up; and this can be again distinctly identified by the number with which its article-symbol is commenced. It will be noticed here, that the piece-number runs into higher figures than with some other kinds of machinery, which is supposed to happen on account of the very large number of pieces in a reaper.

In the third specimen the scheme of symbolizing is to use the initial of the word "pistol" as one of the characters, and to designate the different kinds by another letter, it being probable that there would not be more than twenty-six kinds. Should there be, however, a third letter could be used after a while. In this class of goods there is not supposed to be a series of regular sizes, as there is in lathes, pumps, presses, etc. It will be noticed that the shop-number is here given prefixed to the commercial symbol for the piece, it being probable that slight changes would occur in an article of this kind without its distinctive name being altered; and such changes would not be likely to occur by seasons, as in the case of reapers. The shop-number is put high, as pistols are usually a prolific breed of vermin. The first character "D" could of course be a number, instead of a letter, if desired.

In the fourth specimen the case of a stove is given, and the letters used are initials of the adjectives in the name of the stove, rather than of the word "stove" itself, in order to cover the great variety of names necessary, due to the frequent changes of patterns. Probably a good scheme here would be to use the letters "K C" for "kitchen coal" stove (or "C C," if preferred, for "coal cook" stove). A "parlor wood" stove might be "P W," etc. A number used at the beginning of the symbol will designate the size, it being supposed, in the specimen, that there would be but one size (numbered "1") smaller than the "eight inch" given. After running through several numbers, from 1 up, for a given general style, another set from 11 up might be used for some other style, and from 21 up for a third, etc., etc. In the case of stoves, it is not usually practicable to put on a shop-number, but as it is customary, and easy, to cast some kind of marking upon each piece, the piece-symbol will positively identify for ordering duplicate pieces—its letter being changed, as usual, when each alteration is made. The operation and tool-symbols in the specimen explain themselves. In the stove business they can be few and simple.

For sewing machines and such articles the symbols may well be arranged on the same general plan as for pistols and guns. The shop-numbers (if put on) will run high; but they need not be bothered with, in ordering, if the pieces are marked with the proper symbols. The article-symbol can be short, as the maker usually doesn't make anything else, and there are but few kinds.

Regarding article-symbols in general, there must be considerable taste, ingenuity and foresight exercised to plan a good scheme which will be euphonious and convenient, and which will not constantly manifest a fiendish tendency to get itself "all mixed up." The use of the "initial" principle is excellent as far as it goes, and it may oftentimes, as above stated, be employed for important articles—in which case it is convenient on account of its suggestiveness, as an aid to memory. It must, however, be remembered, as was explained in the former paper, that symbol characters are often merely arbitrary. For example, a concern might be making planers, with the second from the smallest crank-planer called "Planer 2 C P"; while the third size of rack-planer might be "Planer 3 R P." They may, after a while, wish to make Pumps or Presses a staple article, in which case the letter P could not belong to either of them exclusively if it had already been appropriated for Planers. In some cases, however, it might be used for these machines also, if the second letter was arranged as the initial of some other adjective than "crank," in order to avoid such confusion as would arise from initializing the terms "crank-planers" and "crank-presses."

In dealing with operation and tool-symbols there is no great rigidity required about not changing; because customers have nothing to do with them, and because when an operation or a tool is succeeded by another one, it becomes forever obsolete, and can afford to bequeath its name and title to its heir-at-law. If there is danger of interfering with a piecework or cost record, a new one can be made with a proper date, which will, of course, indicate the latest revision. It will be noticed, however, that its *complete* name (by which it is identified) does not remain the same, as that part of it consisting of the article or piece symbol, or both, does become different.

A feature of value in the planning of these symbols will be noticed by an inspection of any "string" of four of them in the table, viz.: No two letters or two figures are contiguous upon either side of a hyphen, or, in other words, letters and figures are *alternated* when placed at the beginning and end of different symbols. This is to prevent the danger of running two figures together into one number, in sound, while carelessly *pronouncing* them, without pausing the voice properly at the hyphens. This, in a verbally given order, might cause confusion.

In regard to "shop-numbers":—A quantity of consecutively built articles may all be known in the factory, by the *first* shop-number given to one of them *after* the last change in "style" was made in any of their pieces, and *until* some other change is made. After such other change, then the first number that happens to be used will form another temporary "style-adjective," so to speak; and so on. This same knowledge of change can be had by inspecting all the style-letters of the piece-symbols of that article, but it is sometimes more convenient to express in this general form the "style" of an article, as a whole. If a customer orders a piece, and mentions the shop-number of the individual article for which he wants it, then his article is sure to be exactly like *all* those bearing numbers between certain two numbers, higher and lower than his, which occurred at the times of style changes. This will hold good just the same if a certain size or kind of articles are not numbered consecutively (but with gaps) as occurs sometimes where each individual of a type (regardless of size, etc.), is numbered in sequence.

A few general rules, for the guidance of the designer in getting an article ready for the market, after it has been perfected to a standard of excellence which probably will not require a great deal of altering for some time to come, may be expressed as follows:

1st.—Give the *article* its symbol, consisting of two, three or four characters, preferably all letters, but perhaps partly figures or all figures, as euphony and the probable taste of the public may require. For commercial uses prefix this symbol with a noun which expresses the most general and best known name of the article in question, as "Lathe 13 K," "Press A C M," etc. If practicable, let the last character, at any rate, of the symbol, be a letter rather than a figure, to avoid possible confusion with the piece symbol which follows, when the symbols are *spoken* in series. Take a long look ahead, trying to anticipate future additional sizes and kinds of the same article, and other analogous articles, so as to arrange a comprehensive system which will logically fit them all. If the article is suitable, a scheme may be adopted wherein one of the characters of the symbol is to represent the general *type* of article, one a particular *kind*, and the remaining one (should there be three) the *size* in a series of the same kind. If there are but two, indicate type and size. If the figures 1, 2, 3, etc., or the letters A, B, C, etc., are used to designate sizes, try to foresee the smallest possible size of that particular series that might ever be built, placing the first size built far enough along so that the smaller ones may have the small numbers, or the early letters, alphabetically considered. If the article in question is of a very important type, and is likely to be permanently produced by the concern, its initial letter may be used for the type, the initial of the proper adjective for the kind, and a letter or number, in proper sequence, for the size, as above indicated. If the article has some variable quantity (as the bed length of a lathe), while other general sizes remain the same, a scheme may be used where one or two figures in the symbol express such quantity—the other figures or letters indicating size, or type, or both. This may sometimes require four characters, as "12 B L" for the second size of a 12-foot bed lathe—"8 C L" standing for the next larger size when it happened to have an 8-foot bed. Other appropriate schemes may be devised suiting special conditions. Sometimes two symbol characters will suffice. In some cases their arrangement may have to be merely arbitrary.

2d.—For factory purposes give each standard article, as above defined, its symbol alone, as "13 K" instead of "Lathe 13 K"—this for the sake of brevity, in speaking it, and in writing and stamping it upon paper and metal.

3d.—Give each *piece* (or group of pieces which cannot be taken apart) a number of its own, all numbers being properly "gapped" to allow for future interpolations—according to the general scheme given in the former paper. With this number place a letter representing the "style" of the piece, that is, "A" for the first construction, "B" for the second construction after one change, etc.

4th.—Carefully analyze the necessary *operations* upon every piece, so that each one may represent the effort of one person (or allied group of persons) during one period of time devoted to it only. Give each operation a number, preferably reserving the first ten for buying and preparing material, etc., and starting regular machine-shop operations at, say, No. 11. In this numbering allow plenty of "gaps" for future changes and alterations due to improved methods or special machines.

5.—Give to each *special-tool* (or separate part of a tool not attached to other parts) used in each operation, a letter of its own—as "A" for the first tool used, "B" for the second, etc. In this case the exact sequence is not of much importance, as there are usually not

very many of these tools. Should there in a rare case be more than 26, use double letters after exhausting the single ones. The "gapping" of letters is not usually necessary, as sequence must not be depended on; but rather standard instructions for the conduct of operations. If a tool will do for two or more pieces, or two or more operations on the same piece, or both, mark it with all the symbols of the pieces or operations to which it is common, thus:

"D P — $\frac{2\ H}{3\ A}$ — 15-B," or "D P — 2 H — $\frac{15}{17}$ — B," or "D P — $\frac{2\ H}{3\ A}$ — $\frac{15}{17}$ — B."

6th.—In general, *mark* the article with its symbol upon the most important piece, usually the frame, prefixing it with the noun representing the full commercial name of the article, if desired. This marking may be in cast, stamped or painted letters, and should preferably not be upon a separate name-plate, as the latter is too easily removed, and so the identification of the article lost. If practicable, and not too expensive, stamp or otherwise mark each piece with its piece-symbol. In some cases, where a perfect individual identification is desired, the article-symbol may be prefixed, but this, in most cases, will be too much trouble.

7th.—*Mark* the article-symbol upon all main drawings, and the piece-symbols upon or near each piece on detail drawings. In cases where pieces themselves are to be stamped or otherwise marked, the location of such marking will show upon the drawings, and will serve the purpose just indicated. Where practicable, mark the piece-symbol on the pieces exposed to view on the various views of the main drawings. This is best done with blue ink, diagonally, that it may be distinguished from the black lines of the drawing and the red dimension-figures, etc., both by color and general position. Mark all patterns with the article-symbol, followed by the the proper piece-symbol, with a hyphen between. Preferably the name of the "concern" should precede the symbols, thus identifying the pattern in all respects when sent to outside foundries, etc. If desired, these symbols may be followed by the operation-symbol representing the "casting" of the piece, and the proper tool-symbol for the pattern—regarded as a "tool." The latter method is of course the most systematic, and logically agrees with the treatment of other special-tools. It is, moreover, of practical use where metallic patterns may be mistaken for castings made from them. In many cases, however, such refinement is not necessary, and the first two symbols only may be used. Each separate member of a pattern should be labeled, and if some member is changed about with other pieces, so as to make more than one kind of casting, it should show all the piece-symbols pertaining thereto. Mark other special-tools (logically speaking, working-drawings as well as patterns should be regarded and treated as special-tools), such as gauges, jigs, special boring-tools, etc., with the article, piece, operation and tool-symbols, strung out in proper sequence, with hyphens between. Of course it is better to also have on them the name or initials of the concern; but as such tools should have a definite bin, drawer or other place in the shop where they are always kept (which place should invariably be labeled with the same mark as is the tool) this latter marking is not so essential as it is in the case of patterns, which are apt to be sent out to various foundries. On large jigs, etc., the marking may be in large painted characters, as well as in stamped smaller ones. Where tools are already hardened they may be etched. Where practicable, paint jigs and such like a distinctive color, not used on articles of manufacture. Vermilion often serves a good purpose.

8th.—Keep proper *index-books*, arranged in columns somewhat as described in the former paper, but amplified for the additional symbols not there mentioned. This is that full information may be kept regarding the birth, growth, development, and perhaps the death, of each article and each piece thereof ever manufactured by the concern. The form of such books will of course vary with the nature of the business, and the skill and taste of the owner; but if the general principles herein indicated are carried out it will be found that the system is comprehensive enough to allow such considerable latitude in the way of details, that no concern need feel that it is necessary to adopt the exact system of some other one.

Shop Notes.

BY JARNO.

No. 13.

SCREW-PITCH THREAD—TERMS USED IN CONNECTION WITH A WORM.

If we have an axial slice section of a screw, can we tell the pitch of the screw?

A slice section is one that shows the outline of anything at the place sectioned, and does not show any part that is back of, or below, the place sectioned. An axial slice section of anything that has an axis represents the outline of a section, from the axis to the outside. In Fig. 1 we have an axial slice section of a screw, the end of which is shown in Fig. 2, the slice having been cut out of the groove *A*.

Now what is the pitch of this screw?

When used in connection with machinery, the term pitch is commonly applied to three kinds of work: the pitch of holes, as of rivet holes in boiler plates, is the distance between the centers of two adjacent holes; the pitch of a gear is the distance between the centers of two adjacent teeth, measured along the pitch line; the pitch of a screw, as defined by Webster, is the distance, measured on a line parallel to the axis, between two adjacent threads, or convolutions of the screw. From the foregoing it would appear that, if we have an axial slice section of a screw, and wish to know its pitch, we have but to measure the distance between the notches or peaks, as at *P*, Fig. 1. Again, there are in the market, tools called screw-pitch gauges, which consist of several pieces, notched something like Fig. 1, each piece being a gauge for a single pitch. A gauge that has notches one-eighth of an inch apart is stamped with the figure 8, signifying that the gauge thus stamped is for screws eight threads to one inch. Now, if we put an eight-to-the-inch screw-pitch gauge against the slice section, Fig. 1, and the notches of the gauge fit those of the section, we shall conclude that the screw, Fig. 2, is one-eighth inch pitch, according to the intent of the gauge makers.

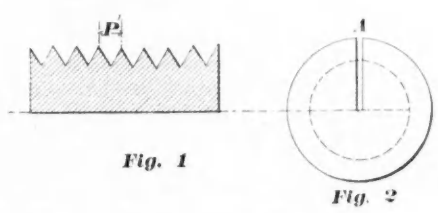


Fig. 1

Fig. 2

A screw that drives a gear is called a worm, the gear being called a worm gear, or a worm wheel. In Fig. 3 we have an axial slice section of a common form of worm. A few teeth of a wheel are shown in mesh with the worm section. The outline of the worm section is the same as that of a rack. As the worm meshes with a gear the pitch of the worm must be like that of the gear, in the sense that the term pitch is applied to a gear. Hence, the pitch of the worm is the distance between the centers of two adjacent teeth in the slice section as at *P*, Fig. 3.

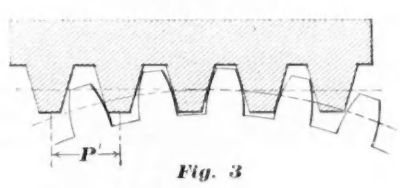


Fig. 3

The teeth of a worm wheel and the thread of a worm can also be given in diametral pitch, the same as the teeth of a gear and a rack, but this does not affect the question we are considering.

Now if the foregoing were all that is meant by the term pitch, when applied to a screw, or to a worm, we would say that we can tell the pitch of a worm when we have its axial slice section. But when applied to a screw, or to a worm, the term pitch has another meaning. The mathematical conception of a screw is that of a helix, or a line that winds around a cylinder and moves endwise as it winds. The distance that the helix moves endwise, when it has made one turn, is called the pitch of the helix. A screw or helix that moves more than one inch in one turn is often called a spiral. With a machinist, the helical line of the mathematician becomes a thread; a screw being a cylinder upon which is wound a thread at a constant angle with the axis, or, a screw is a cylinder in which is cut a helical, or spiral groove, leaving the thread solid with the body of the screw. Thus in Fig. 4 we have a three-cornered thread wound around a cylinder, making the common sharp-threaded screw. This screw has but one thread, and is commonly called single-threaded. The term one thread does not mean one thread to the inch. One thread, or a single thread, can be wound around a cylinder any number of times in a given length. Each complete winding of the thread around the cylinder is called a convolution. Hence, when we speak of a single-threaded screw as having a certain number of threads to one inch, we mean that the thread winds around this number of times in one inch; or, what is the same thing, the number of threads to one inch is the number of convolutions to one inch. A convolution in a screw corresponds to a coil in a spiral spring. A screw can have any number of threads. The screw, Fig. 5, has two threads, and is commonly called a double-threaded screw. Fig. 6 has three threads, or is triple-threaded. For threads more than three, the terms four-threaded, or five-threaded, can be used in order, though fourfold is quadruple, fivefold is quintuple, sixfold is sextuple, sevenfold is septuple, and eightfold is octuple. In Fig. 4 the distance that each turn of the thread moves, in a line parallel to the axis, is the same as the distance between two adjacent threads. That is, one turn of the nut *N* would move it the distance *h p*, which is equal to the distance *P'*. In the double-threaded screw, Fig. 5, the distance that each turn of the thread moves in a line parallel to the axis is equal to twice the distance between two adjacent threads. Thus, one turn of the nut *N* moves it the distance *h p*, which is twice the distance *P'*. In the triple-threaded screw, Fig. 6, one turn of the nut *N* moves it the distance *h p*, which is three times the distance *P'*.

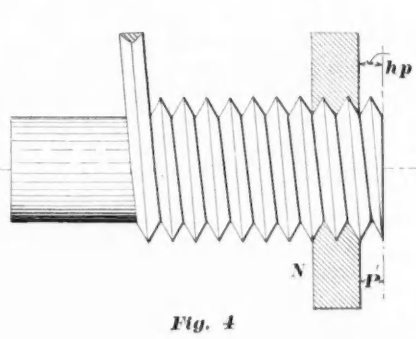


Fig. 4

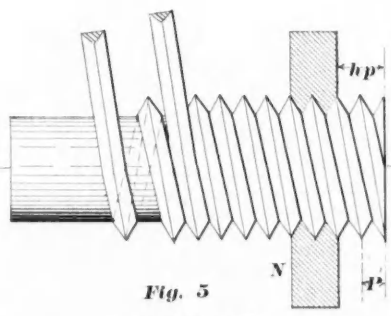


Fig. 5

Lead = $\frac{1}{2}$" = 4 *to* 1"
Thread Pitch = *P'* = $\frac{1}{4}$" = 8 *to* 1"
Double Threaded

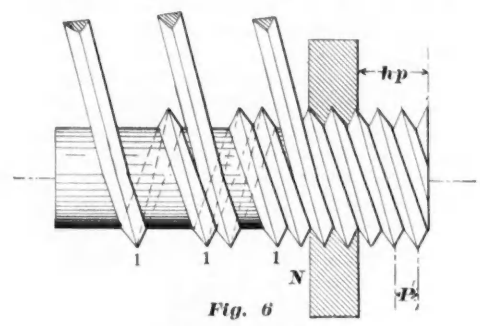


Fig. 6

Lead = $\frac{3}{4}$" = 2$\frac{1}{4}$ *to* 1"
Pitch = *P'* = $\frac{1}{8}$" = 8 *to* 1"
Triple Threaded

Now, in the technical books we are met by the definition that the pitch of a screw is the distance, measured parallel to the axis, between two convolutions of the same thread, or, what is the same thing, the pitch is the distance that the screw would move in a nut, when turned once around. In Fig. 6 one of the threads is marked *l*, *l*, *l*, as it comes round on the under side. The technical books say that the pitch of this screw is the distance between the convolutions *l*, *l*, *l*, no matter how many other threads are between *l*, *l*, *l*.

Here we have a lack of clearness in the meaning of terms. The pitch of a worm may mean the distance between two adjacent teeth or threads; or the pitch may mean the advance of a thread in one turn of the worm. To fix on terms that are clear is the object of this paper.

To define so simple a thing as the advance of a screw thread in one turn of the screw, it would seem that there should be the same terms used by different authors. But their terms differ. Willis says simply *pitch*; Rankine says *axial pitch*, and also *total axial pitch*; Unwin says *axial pitch*; MacCord says *helical pitch*; Joshua Rose says *true pitch*. The Brown & Sharpe Manufacturing Co. and the Pratt & Whitney Co. say *lead*. From these terms I would select *helical pitch* and *lead* as being clear and exact when applied to the advance that a screw thread makes in one turn of the screw, and as being the best for common use. To me, *helical pitch* is the most expressive, though *lead* may be preferable in the shop. The meaning of these two terms is the same, and when either of them is on a drawing it should not be misunderstood.

To designate the distance between two adjacent threads, when a screw has more than one thread, Rankine says *divided pitch*, and Unwin says *divided axial pitch*. These terms are well enough technically, but they are hardly suited to the workshop. In speaking of the distance between two adjacent threads of a worm, it is correct to use the same terms that are applied to a rack. That is, the *circular pitch* is the distance *P'* in Figs. 4, 5 and 6. If, upon a drawing, we use the term helical pitch, or the term lead, we can upon the same drawing say simply pitch, instead of circular pitch, to designate the distance between two adjacent threads. I would also suggest that the words *screw pitch* can easily be understood to mean the same thing as helical pitch or as lead; and that the words *thread pitch* can be understood to mean the distance between two adjacent threads or convolutions of a screw, or of a worm. The term circular pitch might not be quite clear when applied to a screw that does not drive a gear.

In summing up, if *P'*, Fig. 5, is one-eighth inch, we would say that the lead, or the helical pitch, is one-quarter inch, or four to one inch, and that the thread pitch is one-eighth inch, or eight to one inch. Under Fig. 5 is seen what can be put on a drawing. Under Fig. 6 is seen what can be put on a drawing for a three-threaded or triple-threaded worm to drive a gear of one-eighth inch circular pitch.

In seeking information upon the subject of terms used in connection with a worm, I have written to George M. Bond, with the Pratt & Whitney Co., to Frank Bement, of Bement, Miles & Co., and to Ambrose Swa-

SHOP NOTES.—SCREW-PITCH THREAD.

sey, of Warner & Swasey. I hereby thank each for his kind and full answer. They all see the need of a better understanding as to terms to be used. I hope that this paper will meet with their approval, and with the approval of each reader of the American Machinist.

LETTERS FROM PRACTICAL MEN.

Cast vs. Cut Gears.

Editor American Machinist:

In a recent issue of the American Machinist, W. H. Booth makes the statement, in his very interesting letter on quick-return planers in England, and their antiquity, etc., that the foundryman must be deficient in skill if he cannot cast a gear with teeth that are true to pattern, and it should run as well as a cut tooth gear, all other conditions the same, or words to that effect.

The question arises, if it would be possible to make, in England, with English irons, a true gear, or nearer truth, than could be done in America, with American irons, all other conditions being the same. Everyone who is familiar with American irons, and loam founding, knows that great variations exist in castings from the same mixtures of different brands of iron, caused by the difference in temperature at which the metal is poured, how soon shaken out, and how placed when shaken out—if in piles with others, or separate, etc. These variations in shrinkage are multiplied tenfold, if changes are made in the brands of iron.

The writer witnessed a splendid attempt to lessen machine work on a large contract for columns. To save something, chills were made to cast the ends right to size and true. Excellent provision was made to set the chills in the mould so as to have them come true. One was cast as a sample, to see just how much the shrinkage would be, and subsequent ones were made, with shrinkage allowance, as per first one or sample. There were some ninety or more of these columns for Back Bay, Boston, Mass., over the P. & B. R. R. Sane street extension there. The result of all this preparation was, that there were not three columns in the lot that were exactly the same length, and special plates were cast to suit the individual lengths.

An attempt to substitute cut with machine cast gears came within the writer's experience.

The owners and inventors of a machine for moulding gears had every inducement to get perfect cast gears, but, in a trial of about a dozen gears, there was not one that would run smooth, and it was abandoned, and the experimenters returned to the cut tooth gear.

The fact about a gear, or anything round in the cast-iron line, is, that it is not round; and, owing to the unequal contraction of the metal while cooling, the piece, whatever it may be, will flatten, so to speak. There are such a multitude of causes for the unequal contraction, that it is impossible to govern all of them, and hence the inferiority of cast gears, compared to cut, for smooth running.

Now, the question that would interest many to have answered is, "Do American irons contract more than European irons?" It is generally admitted that American irons are stronger, more dense, a trifle harder, and more stubborn to work, hence they no doubt do contract more than foreign irons; at least the writer is under that impression.

L. C. Jewett.

Drawing-Room Expenses.

Editor American Machinist:

I would like to say in reply to B. Crank's criticism of my previous articles on the above subject, that he must have failed to carefully read my first article, otherwise he would have seen that I only tried to show how much I valued Chordal's instructions by their complete adoption in my work, and the advantages gained thereby.

They were written about eight years ago, and were the foundation laws to guide to improved systems, lasting long after the old "I-know-it-all" methods have passed away. I think their author would think little of us if we swallow them down in a lump without any effort to adapt them to circumstances that immediately surround us.

Seeing an excellent set of shop rules in a factory once, I asked the proprietor for a copy. He gave me a printed copy, but I did not nail it up in the shop with which I was connected until the trimmings were altered to suit circumstances without destroying their general intent.

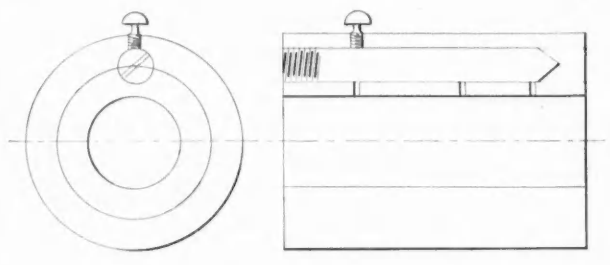
B. Crank will pardon me for not reading the preface of Chordal's book, when I tell him there wasn't any in the copy I read, as I presume the chap that borrowed it before I did had torn it out. He undoubtedly knew a good thing when he saw it.

The article of C. L. Redfield reminds me of an article of instruction in drawings in another mechanical paper recently, in which the writer, after long explanations as to care of tools, use of paper, ink, etc., and instructions as to their use, finished his article with a sort of moral, the gist of which, as near as I could make out, was, "that it was a good thing to know, but not essential, and nobody did it that way now-a-days anyway."

Mr. Stillman's reference to shrinkage of blue prints is well taken. I have found that genuine helios paper shrinks about $\frac{1}{16}''$ in 30″ sheets, if allowed to dry in a cool place, and the same sized sheets will shrink nearly $\frac{3}{8}''$ dried by a stove. The other cheaper grades of stock are liable to shrink anywhere.

Another thing I do differently from text book rules: I make dimension lines full, instead of broken.

Now, which is safest, on a soiled drawing, or dark-blue print? W. S. Rogers.



Scheme to Facilitate Oiling.

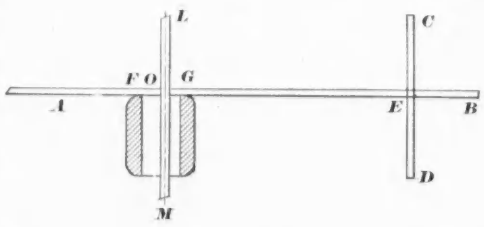
Editor American Machinist:

I had to put a new bush in the fly-wheel of the punch the other day. I tried a scheme to facilitate the oiling.

While I had it in the drill press to drill for a dowel, I drilled a $\frac{9}{16}$ hole in the hub, as per sketch. I tapped the open end for a $\frac{3}{8}$-pipe and closed it with a plug, which can be removed to clean out the hole.

I stopped up all the old oil holes except one. This I tapped for a $\frac{1}{4}''$ pipe thread and got a T head plug out of the scrap. By the old way, when the wheel had made a half revolution, the oil all dropped out of the hole. Stuck.

Decatur, Ill.



The Pitch Compass.

Editor American Machinist:

I observe in your issue of October 27, Query No. 464, in relation to measuring pitch of screw propellers, "Whether any patent for a machine to obtain the pitch of a screw propeller has ever been taken out;" and in your issue of November 24th a note from your correspondent, Mr. Booth, as follows: "There was an instrument devised within the past five years for measuring the pitch of screw propellers," etc.

Now I would call your attention to the fact that Professor Robert Rawson, of Portsmouth Dock Yard, England, invented a very simple instrument for this purpose in 1850, and published a description of it in his work on "Screw Propellers," in 1851.

After explaining the principle upon which the instrument is designed, he proceeds to give a description of the instrument, and manner of using it. The term or name which he gave it was the Pitch Compass.

The following is his description:

"By this instrument [the pitch compass], the pitch of the screw at any distance from its axis can be readily ascertained; and I think it right to state that more labor, with greater accuracy, can be performed by one man in a few minutes with the pitch compass than by three men in several hours by the old methods.

"The pitch compass is very simple in its construction and use, as the following description and application to practice will show:

"*F G* is a section of the boss of the screw, and *L M* its axis; *A B* is a beam compass, whose center *O* is the center of the boss through which the axis of the screw blade passes.

"The beam compass *A B*, which is made sufficiently long to extend from the axis *L M* to the extremity of the screw blade, is divided into feet and inches, and constructed in such a manner that it will turn around the axis *L M*, fixed on a graduated circular disk, with perfect freedom.

"*C D* is a brass rod, graduated into inches and tenths of inches, placed neatly in a groove, which is fixed firmly to a slide which moves freely from *B* to *O*. The rod is allowed to move in the groove in the direction of *C D*, at right angles to *A B*, and the slide and brass rod can be fixed in any position by means of clamp screws.

"Suppose it be required to measure the pitch of the screw blade at a distance of *eight feet* from the axis of the screw. The slide *E* is then fixed by a clamp screw at a distance *O E, eight feet* from the center *O*; then the height *E D* of the beam compass from the screw blade is observed to be *seven inches*. After this, the beam compass *A B* is moved gently round through an angle of *thirty degrees*,* marked on the graduating disk on which the center *O* is fixed, while the slide and brass rod remain fixed; the brass rod is then lowered, so that *D* again touches the blade of the screw, and the height *E D* is now observed to be *twenty-five inches*.

"The difference in the height of the beam compass *A B* from the screw blade in the two positions is *eighteen inches*; therefore the pitch of the screw blade is *eighteen feet*.

"A pitch compass has been constructed by the author, for the use of the Master Shipwright of Her Majesty's Dockyard, Portsmouth, and Andrew Murray, Esq., Chief Engineer of Her Majesty's Dockyard, Portsmouth, has made an admirable one for his use in the public service, on the same principle as the above.

"By means of the pitch compass, the screw propeller for the 'Dauntless,' whose diameter is 14 feet $8\frac{1}{2}$ inches, was measured, and found to be:

Radius.	Pitch.
7′ $4\frac{1}{2}''$	16′ 4″
5′ 9″	16′ $7\frac{1}{2}''$
5′ 0″	16′ $9\frac{1}{2}''$
4′ 0″	16′ 11″
3′ 0″	17′ 2″

"Hence the pitch of the screw increases from the extremity of the blade to the axis."

C.

* The reason of moving the beam compass through 30 degrees is evidently that the arc of 30 degrees bears the same relation or proportion to the full circle as one inch bears to one foot; that is, 1-12th. Of course, other proportions may be used.

Rope Driving.

Editor American Machinist:

I notice in an article by Mr. Brown, on Rope Driving, in the American Machinist of July 21st, that he gives the effective working tension of the ropes, without reference to the centrifugal stress, which makes the total tension upon high speed rope so very much in excess of its apparent tension. Very nearly, the additional tension due to centrifugal force is $\frac{WV^2}{32}$ where W is the weight per foot run of the rope, and V its linear velocity in feet per second. Of course, the working strength of the rope determines its nominal tension, which must vary with the velocity. The working tension must, in fact, be simply the difference between the allowed total tension and the centrifugal tension. As the latter increases as the square of the linear velocity, whilst the efficiency of a rope only increases directly as the velocity, it follows that, beyond a certain speed, there is no advantage in increase of velocity. At a certain high speed, in fact, the centrifugal tension entirely absorbs the strength of the rope, which can only draw itself around. Hence there is an early limit, beyond which it is not well to go. For cotton ropes this limit is about 7,000 feet per minute, whilst 5,000 is the probable best speed for maximum efficiency, as it is obviously unwise to run faster than 5,000 if the higher speed gives no increase.

Rope gearing, as Mr. Brown says, absorbs more power than either belts or teeth, but ropes are so very convenient in application that they have become almost universal. They [in England] do not, however, take up so very little room, and all new factories built for rope driving have a special rope chamber built in, suitably fitted with platforms and staircases to give access to the pulleys on the various second-motion shafts and their bearings, which are double, and should be at least three diameters long, to prevent undue wear from the tension of the ropes.

The following few particulars of rope installations may be of interest.

Name.	No. of Ropes.	Diameter of Ropes.	Speed p'r Minute.	I. H. P.	I. H. P. per Rope.	Nominal Tension.	Weight per Foot.	Speed p'r Second.	Centrip. Tension.	Total Tension.
A	40	$1\frac{3}{4}''$	4700	2500	62	435	1.0	78	190	625
B	27	$1\frac{5}{8}''$	4664	1200	45	318	.86	78	164	482
C	10	$1\frac{7}{8}''$	2827	260	26	304	1.15	47	79	383
D	20	2″	4528	600	30	219	1.3	75	229	448
E	20	$1\frac{3}{4}''$	4141	407	20	162	1.0	69	149	311
F	14	2″	3760	450	32	278	1.3	63	161	439

Cases *A* and *B* are quite recent examples, and show the increased confidence placed in ropes as the result of experience.

The case *E* is an example of a mill altered from tooth gears to ropes. Before the change, the power developed was only 327 horse-power, showing a large loss in the ropes. Of this case, however, we may say definitely there are double the necessary number of ropes, as I pointed out when the change was made, now some seven years ago.

If worked out per area of rope section, the smaller ropes would, of course, show a proportionately higher stress, and the first two cases would appear still further in advance of the older examples.

Case *A*, thus figured, will run out at nearly double the total tension of case *D* or case *F*, while case *B* is really very near to case *A* in actual stress per fiber.

In addition to the total stress made up of the work and speed, there is always something further to be added for the tension of the rope itself, which increases the total running tension by the amount of the tension on the slack side of the rope. This, of course, varies with the tightness of the rope, and is, therefore, dependent upon the length between pulleys, and the amount of sag allowed. This may always be considerable, for with a quite slack return side it does not appear that slipping takes place; and as the return side is, or should be, always the upper side, any slackness adds to the length of the circumference of pulley embraced by the rope, and so assists its grip. With slack ropes, as with belts, the working is easier and better; and actually, the "initial" tension of the so-called theoretical man, who deals with impossible *inextensible* cords, does not require to exist in practice, the grip of the rope on the *V* grooves being amply sufficient to ensure a proper hold with such slack side tension as given by the weight of the hanging catenary of slack rope. In some mills the whole of the driving is done by ropes, no cross shafts at all being employed, there being, in fact, not a single pair of wheels in the mill.

Some of the newest mills, on the other hand, have adopted gearing throughout, for

its economy in running, and the saving in space which may be thus effected.

One of the chief disadvantages introduced by the wide rope pulley is the increase in the length between bearings of the crank-shaft, although by proper design this need not be so excessive as at first sight appears; for, by suitable arrangement of valve rods, the shaft bearings may be brought close in to the center or boss of the great rope pulley, leaving room only for the eccentrics.

Rope driving has grown in favor, largely because of the verdict of the spinners themselves, and other inside machine hands. They have found that with ropes they get good and steady turning, and say at once it is due to the ropes, but quite overlook the high speeds of the immense rope pulleys, which are also so much heavier than the old spur wheels, and so very much larger in diameter. In spur gears, diameters of 20 to 24 feet were usual in large engines, whilst for ropes the pulleys are 30 to 36 feet diameter. The speeds are higher, and the pulleys are double the weight of the old spur wheels.

The second-motion shafts are now the line shafts, and each carries a rapidly revolving rope pulley. The ropes themselves act as "fly wheels" also. All this shows that the steadiness of rotation is due to the weight and speed of the revolving masses, and probably as good results would be obtained from spur gearing with a heavier fly-wheel. Many rope pulleys weigh close upon 180,000 pounds.

The loss spoken of by Mr. Brown as being due to pulling the ropes out of their wedge grooves, is, I think, more due to the differences between the ropes themselves. In some 30 ropes, divided into four or five groups of different lengths, it is difficult to secure the conditions necessary to minimum friction. These conditions are that every rope should be: (1) of one length; (2) of uniform tension; (3) of uniform elasticity; (4) of uniform diameter.

The first condition is impossible, for there are always several groups of two, four, five, etc., ropes per group, according to the weight of machinery per line shaft driven; and while one group of ropes drives the bottom floor, another drives the second, and so on, up to a fourth or fifth floor.

The first condition is not important when lacking only between different groups, because each group is virtually independent, and the best result will be obtained when each single rope drives an independent pulley. It is important, however, that each rope in a group should be uniform in length, because, if not, the slacker ropes will have the greater sag, and, therefore, the least total tension. Having less tension, they will sink less deeply into their grooves, and as by doing so they virtually increase the diameter of the driving groove pitch line relative to that of the driven groove, these ropes have a differential velocity upon the pulley relative to the other ropes. A greater length of them will be taken up by the driver pulley than will be given off from the driven. The result, of course, will be simply an increase of the driving side tension and a forcing deeper into the groove, so tending to correct the fault at one side. It is not easy to say exactly what the details of the rope's behavior may be, but the net result must be friction and loss. Condition (2) of uniform tension may be said to be the parallel case with (1), and can only exist when No. (1) also obtains. A variation in No. (3) of course means that some ropes will stretch less than others, and so do more work and disturb conditions (1) and (2). Of condition (4) it may be said that any failure in uniformity on this score between the ropes of a set implies a deeper sinking into the grooves of the smaller ropes, and a disturbance of the pitch line ratios of the driver and driven rims.

Virtually all faults result in a disturbance of this rim ratio, and consequent friction. Often such a disturbance is caused by some of the ropes revolving on their own axes, whilst others bed themselves to their grooves and become partially triangular in section, whilst the revolvers maintain their circular form, wearing all round.

W. H. BOOTH.

Modern Locomotive Construction.

BY J. G. A. MEYER.

SEVENTY-NINTH PAPER.

The favorite locomotive main rod is the solid one of rectangular form; that is to say, a rod whose transverse section is similar to that shown in Fig. 453; they are made stiff enough so as not to buckle.

Main rods are subjected alternately to a tensile and compressive force, due to the steam pressure on the piston; the intensities of these forces are increased by the obliquity of the rods, and also by positions of some of the mechanism which at times must work out of alignment when the engine is running over curves or uneven tracks. The compressive force has a tendency to buckle the rods in the direction of arrow 2 (Fig. 457); in order to prevent buckling in this direction, a definite thickness at C and D (Fig. 457) will be required; in all main rods this thickness is uniform throughout. The main rods are also subjected to a transverse force, due to the centripetal acceleration, and this force has a tendency to bend or break the rod in the direction of arrow 3 (Fig. 456); to prevent any change of form in this direction, a definite depth at A and B will be required; this depth increases uniformly from A to B.

The thickness and depths of main rods, made by different builders and master mechanics, for the same class and size of locomotives, vary somewhat, but the average of good practice seems to point to the following proportions:

In the smallest transverse section of a main rod, that is, at A, the depth $f\ h$, Fig. 453, should be equal to $1\frac{3}{4}$ times the thickness $f\ g$; the depth at B, Fig. 456, should be 25 per cent. greater than that at A; and furthermore, the area of the transverse section at A should be such as to contain one square inch for every 5,000 pounds of the total maximum steam pressure on the piston. Hence, within the limits of ordinary locomotive practice, we may adopt the following rules, which are based upon the proportions just given.

Rule 63. To find the area of the smallest transverse section of a main rod, that is, the area of the cross-section at A, Fig. 456, divide the total maximum steam pressure on the piston by 5,000; the quotient will be the number of square inches in the area of the transverse section at A.

Example 96. The maximum steam pressure on a piston in a consolidation engine is 120 pounds per square inch, cylinders 20 inches diameter, what should be the number of square inches in transverse section through the smallest part of the main rod?

The area of a 20-inch piston is 314.16 inches; the total maximum steam pressure on the piston will be equal to

$$314.16 \times 120 = 37{,}699.20 \text{ pounds,}$$

and the number of square inches required in the area of the smallest cross-section of the main rod will be equal to

$$\frac{37{,}699.20}{5{,}000} = 7.53 \text{ square inches.}$$

Rule 64. To find the thickness and depth of the main rod at its smallest transverse section, that is, at A, Fig. 456, and also the depth of the rod at B, multiply the cross-sectional area of the smallest section of the rod, as found by Rule 63, by 4, and divide the product by 7; the square root of the quotient will be the required thickness C or D (Fig. 457) in inches.

To find the depth of the rod at A, multiply the thickness in inches of the rod by 1.75; the product will be the depth in inches at A. For the depth at B, increase the depth of A by 25 per cent.

Example 97. What should be the thickness and depths of a main rod for a consolidation engine, having cylinders 20 inches diameter, steam pressure on piston 120 pounds per square inch?

Here we must first find the area in square inches of the smallest cross-section of the rod, that is, at A. In the last example we found this area to be 7.53 inches. Hence, the thickness of the rod will be equal to

$$\sqrt{\frac{7.53 \times 4}{7}} = 2.07 \text{ inches.}$$

The depth of the rod at A will be equal to $2.07 \times 1.75 = 3.62$ inches.

The depth at B will be equal to $3.62 + (3.62 \times .25) = 4.52$ inches.

Avoiding fractions less than $\frac{1}{16}$ inch, we find that the thickness of this rod should be $2\frac{1}{16}$ inch; the depth at A, $3\frac{5}{8}$ inch; and the depth at B, $4\frac{3}{16}$ inches.

Example 98. What should be thickness and depths of a main rod for an eight-wheeled passenger engine, having cylinders 18 inches diameter, maximum steam pressure in cylinder 140 pounds per square inch?

Fig. 453

Fig. 454

Fig. 455

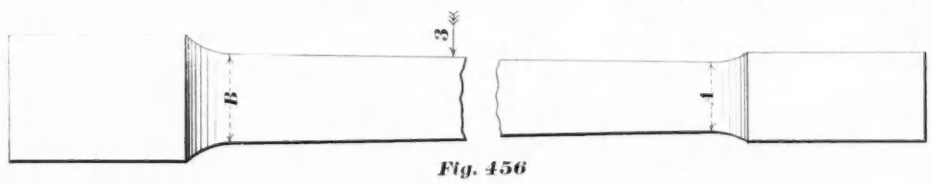


Fig. 456

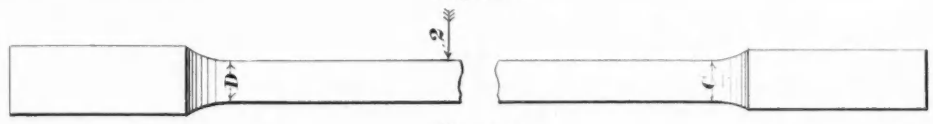


Fig. 457

The total maximum steam pressure on the piston is equal to $254.47 \times 140 = 35{,}625.80$ pounds.

According to Rule 63, the area of the smallest cross-section should be equal to

$$\frac{35{,}625.80}{5{,}000} = 7.12+ \text{ square inches;}$$

and according to Rule 64, the thickness of the main rod will be equal to

$$\sqrt{\frac{7.12 \times 4}{7}} = 2.01 \text{ inches.}$$

The depth of the rod at A will be equal to

$$2.01 \times 1.75 = 3.51 \text{ inches.}$$

The depth of the rod at B will be equal to $3.51 + (3.51 \times .25) = 4.38$ inches. Avoiding fractions less than $\frac{1}{16}$ inch, the thickness of the rod will be 2 inches; depth at A, $3\frac{1}{2}$ inches; and depth at B, $4\frac{3}{8}$ inches.

It will be noticed in these examples, that in the small transverse section of the rod, the side $f\ h$, Fig. 453, is $1\frac{3}{4}$ longer than the side $f\ g$. Should it be required to have a different ratio between these sides, say that $f\ h$ shall be $1\frac{5}{8}$ longer than $f\ g$, then multiply the area in square inches, as found by Rule 63, by 8, and divide the product by 13; the square root of the quotient will be the thickness; and the thickness thus found, multiplied by $1\frac{5}{8}$, or 1.625, will give the depth of the rod at A.

The foregoing rules are only applicable to locomotive main rods; and even in locomotive practice, these rules will only give satisfactory results so long as the length of the main rod is not greater or much greater than 60 times the width of the rod found by these rules. Main rods whose lengths are greater than 60 times the thickness, or connecting rods for other engines in which the ratio between the length of the rod and the maximum steam pressure on the piston differs greatly from ordinary locomotive practice should be treated as upright columns or pillars, with rounded or pointed ends supporting a load; and the dimensions of these rods should be found by rules given in books treating on the strength of material.

Sometimes we find locomotive main rods with the edges chamfered, whose cross-sections will appear as shown in Fig. 454. This we believe to be bad practice, as it cuts the metal away in places where it is needed the most. Chamfered edges do not add to the beauty of a rod, but unnecessarily increase the expense of making them, and when done no advantage whatever is gained. The best practice is simply to take off the cutting edges to as small degree as possible, so as to prevent a person cutting his hands or otherwise hurting himself in oiling, cleaning or inspecting a locomotive.

Sections of rods, as shown in Fig. 455, should also be avoided, because such forms only impair the strength of the rod, without gaining any advantage.

Trial of an Electric Locomotive at Birmingham.

The trial trip of an electric locomotive for drawing the tram cars of the Birmingham Central Tramways Company took place on Wednesday afternoon, in the presence of a large number of representatives of the press, the corporation, and of the various tramways companies. The engine, itself weighing $8\frac{1}{2}$ tons, has been constructed upon the Julien system, by Messrs. Elwell-Parker, Limited, Wolverhampton. In the trial, the electric locomotive successfully replaced the steam tram engine now used upon the Birmingham tramways. The gradients in many places are very steep, rising at Bradford street to 1 in 17; but the electric locomotive successfully mounted this steep and long ascent with a load of sixty passengers, at a speed of about five miles an hour. On the level and down hill the speed could be increased to ten miles an hour without difficulty, and the locomotive was started, stopped, and backed with ease. The journey from Station street to Moseley (a distance of about $2\frac{1}{2}$ miles) occupied about 25 minutes. The engine itself is a very neat and compact arrangement, compared with the ordinary tram engines. Two rows of accumulators occupy each side, between which is an alley for the driver, where is fixed the switch, the reversing switch, the engine brake, and the car brake. The switch connects the cells in five sets, all parallel, and two, three, or four in series. The cells number 104, having 39 plates, each 9″ by 6″. The motor is placed low down, and is connected by helical gearing—geared 1 to $8\frac{1}{2}$. The engine is capable of exerting 40 h. p., and is made for running a distance of 60 to 70 miles. No hitch or difficulty of any kind was experienced, and the chairman of the Birmingham Central Tramways Company expressed perfect satisfaction with the results of the experiment; and a contract has been entered into by the engineers to run this car for three months at sixpence per car mile, the present cost of steam being nearly eight-pence. The experiment has conclusively shown that an electric motor engine can accomplish all that is required for a power-driven tramway.—*Industries.*

According to Herr Leonhardt, a German engineer, the number of locomotives in use on German railroads was 12,450 in the year 1885–'86, the average age being 12.49 years. Fifty engines built previous to the year 1850 were still in use at the date referred to, the oldest of which dated from 1845.

Where noise from gearing is objectionable, and smooth working a necessity, vulcanized fiber is being used for teeth with success. It prevents noise, and wears well.—*The Engineer* (London).

AMERICAN MACHINIST

To prevent delays all Communications should be addressed to the Company.

PUBLISHED WEEKLY
BY
American Machinist Publishing Co.
96 Fulton Street, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
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The International News Company,
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The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N. Y

NEW YORK, DECEMBER 8, 1888.

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Will It Pay?

The Central Railroad of New Jersey, for a distance of twenty-five miles or more out of New York, runs through a country of suburban villages, as it were, and the road does a very good business indeed, in transporting commuters and their families to and from New York. The majority of these people live in these villages in preference to others nearer New York, because, altogether, they are pleasant places in which to live.

Until recently, hard coal has been burned in all the company's locomotives, but a short time since, a change was made to soft coal in the instance of the freight engines. This change is not relished by the citizens along the road; the use of soft coal fills their yards and houses with dirt, and sadly interferes with that general state of cleanliness which people hope to enjoy when they leave the city behind. As a result, a dozen ladies, more or less, waited upon the superintendent of the road, in the hope of persuading him to order a return to hard coal. As the story goes, they were told that the use of soft instead of hard coal represented a saving to the company of twelve thousand dollars a year, and hence no change would be made.

No one would expect the railroad management to throw away twelve thousand dollars a year to please the residents along its line. We are not arguing that it should do so. But there is another side to the question. Anything that tends to make these suburban villages unpleasant places in which to live, will help to drive away those who are not permanent residents, and will prevent others from going there. And to that extent the business of the railroad will be injured. It is true that the property owners will suffer much greater loss than the railroad, but, aside from all rights others may possibly have, there is a question if the railroad company can afford to be a party to the doing of this injury for the sum of twelve thousand dollars a year. Of course, the only question the railroad company can be depended upon to consider is: Will it pay?

Piece-Work.

We had something to say recently about piece-work in machine shops. One phase of the subject, which we did not consider at that time, is the stimulus which may be given to invention of improved appliances and methods for doing work by the men, which may easily be made a part of the piece-work system.

In nearly every shop of any magnitude, there is some one employed, a part, or perhaps the whole of whose duties it is to invent and devise new and better machinery, tools, processes and methods of doing work. It is well understood that that is what he is employed for, and, generally speaking, he is paid for that service in proportion to his ability.

The compensation of the men who do the work is not regarded as in any sense a payment for the exercise of inventive skill, but is for manual labor only; accompanied, of course, by the degree of mental ability necessary to the performance of the labor; which may be little or great.

It often happens that such men devise a means whereby the quality, and consequently the value of the work, is much improved, or its quantity increased. Their wages include no compensation for this, and the question of how and to what extent they should be compensated, is worthy of consideration. No one will deny that there should be compensation in some form; there are both moral and business reasons for it. From a moral point of view, no one has the right to appropriate to his own use the products of others' labor without full compensation; and from a business, or merely selfish standpoint, it pays the proprietor of a shop to have it well understood amongst his men, that any service of that kind will be appreciated and paid for at something like its true value. This can be done, and is done, in many shops where the system of piece-work is not in use; but it is obviously easier to determine what is a fair valuation and compensation where the work is paid for by the piece. If a man working at a certain machine is able to turn out in a day fifty pieces of work, for which he receives six cents each, gets up some improvement in the tools used, or the methods employed, by which the production is doubled, he will then, if his price per piece remains the same, make six dollars per day, instead of three, as before. If, as often happens, his improvements are applicable to that particular work, and that particular machine only, he can secure no protection from the Patent Office which will be of any benefit to him, and his employer may, if he chooses, give him his choice between doing the work at three cents, or giving up his place to another, who will be glad to work for the three dollars per day which can now be made at that price. We fancy, however, that few will be found to justify such a proceeding upon moral grounds; but questions of morality aside, there are good business reasons against it, and these reasons may be summed up in the statement that the brains of intelligent workmen are worth more than their muscles; and that, unless their brain labor is made profitable to them, they cannot be expected to render it. A workman treated in the manner indicated above, is embittered, and changed from an enthusiastic, ambitious, thoughtful and energetic workman, whose whole sympathy, power, and good will are enlisted in the service of his employer, to one who is discontented, unambitious, and careless. Not only this, but every man in the shop is bound to sympathize with him, to consider him unjustly treated, and to take pains not to think of any improvements, or to conceal the fact if he does happen to think of one. There is a vast advantage in having a shop full of men who are cheerful, ambitious, and energetic. Other things being equal, the shop filled with such men will make more money, though paying higher wages, than another shop filled with men of the opposite kind.

If the employer in the case cited above had made a clear profit of two cents on each piece of work before the invention of the improvement, he would, after that, paying the same price per piece, make twice as much per day from the labor of that man, without considering the fact that his profits are largely increased, also, from the fact that all fixed charges, such as interest on the cost of shop-buildings and tools, depreciation in value of same, insurance, cost of superintendence and clerk-hire are not increased, while production is doubled. All such fixed charges are therefore decreased fifty per cent. in their proportion of the total cost of the work. If the building and equipment cost one thousand dollars for each man employed, the effect of such increase in productive capacity is better than if that cost were reduced to five hundred dollars per man—a feature often overlooked, but well worth considering in connection with the subject.

Where the work is done by the piece, it is easy to fix upon a fair compensation for improvements, by making a written contract, guaranteeing to the workman the privilege of doing the work for a specified period at a mutually agreed upon price, which may be such that both will make more money than before.

We think it will pay those manufacturers who have given this matter no attention, to think it over, and, in doing so, don't think that because your competitor does not reward his workmen for improvements, you cannot do it, because that very fact enables you to get the advantage in competition. He will secure the service of hands only, while you will secure that, in combination with brains, and your work will cost less than his.

Wasted Energy.

It is a fact pretty well known that a very liberal percentage of the total inventive genius of the country is expended in inventing things not needed, nor likely to be needed. Before going about inventing something it is wise to use diligence in the direction of finding out whether there is likely to be a demand for it. Mere ingenuity to devise, unless well balanced, is quite likely to go astray. When some mechanical arrangement is found in use—some old-time affair that readily shows inherent defects in some of its operations—before spending much time in arranging to supplant it, it is wise to consider all the reasons why it has remained in use. Perhaps a little time spent in reflection and study may save a good deal of time and money. If the arrangement referred to is something in common use, the probabilities are that a good many men have seen its defects, and puzzled themselves over replacing it, hence it is not wise to believe that the first thing thought of is going to accomplish the purpose. The very thing looked upon as a defect may have an important bearing in permitting the accomplishment of some other end, and may be one of the inevitable imperfections submitted to in preference to a more important defect.

Literary Notes.

INVENTOR'S GUIDE BOOK. The Mechanic's Assistant. Three thousand varied Inventions listed for the reader. Geo. A. Ries, Poplar Bluff, Mo. Price 50 cents.

The intention of the author of this little work is to furnish would-be inventors with a list of things from which to select. It appears to cover this ground quite as fully as could be expected.

POOR'S DIRECTORY OF RAILWAY OFFICIALS, now ready, contains lists of the officers of all the railways in North America, and also lists of officers of South American and British roads. In addition to this, the work contains lists of bridge builders, car axle manufacturers, car builders, car wheel manufacturers, rail mills, railroad contractors, and various other matter directly or indirectly connected with railroad matters. It is a work of unquestionable value for those interested in railroad or transportation matters. It is issued from 70 Wall street, New York.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(516) B. S., Charlottetown, Prince Edward's Island, asks: Is there any mixture that is used in tapping cast-iron pipe fittings that is cheaper and cleaner than oil? *A.*—We do not know of anything which will take the place of oil.

(517) X. Y. Z., Paterson, N. J., writes: Will you please inform me how the expansion joint between the steam chest and side pipe of a beam engine is made? I have looked through most of the test books on steam engines, but do not find the information detailed enough on this point. *A.*—See article on Practical Drawing, in last issue.

(518) W. F. K., Hollidaysburg, Pa., sends us a sample of what he calls improved artists' rubber, and writes: In using this rubber to erase pencil marks on drawings, the heat generated by rubbing seems to dissolve it. Can you inform me if there is a special way to use it? *A.*—There is no special way to use it; but you may overcome the difficulty by using a better quality of rubber.

(519) J. H., Winona, Minn., asks for an explanation of the following item, which appeared in a technical journal. "An ordinary steam engine, having two cylinders connected at right angles on the same shaft, consumes one-third more steam than a single cylinder engine while developing only the same amount of power." *A.*—There is no explanation; on general principles the statement referred to is not true.

(520) Crank, ———, Ind., writes: I did not state my question (494) correctly. What I wish to do is to make the cylinder 12×12 of the direct acting pump the high-pressure cylinder, and use its exhaust in the two large cylinders 20″×18″, so as to form a compound system. Will such an arrangement be advisable and advantageous? *A.*—We have not sufficient data to advise you correctly. But such arrangement in compounding is sometimes made and a benefit derived from it. See AMERICAN MACHINIST, April 14, 1888, page 1.

(521) B., Albuquerque, N. Mex., writes: Do you know of an instance where a steam engine is governed successfully by electricity? I can make the governor and have all the material to do it with, but want to know if it will hold the engine

(fitted with a Gardiner governor at present) to the load, and increase or reduce the speed as lamps go on or off? *A.*—We do not know of an instance where a steam engine has been governed successfully by electricity. The speed of the engine should not be changed as the lamps go on or off.

(522) W. C. B., Cleveland, O., writes: I am about to build a small engine 7 inches by 3½ inches. Would you please give me the size of the ports and bridges? *A.*—The thickness of the bridge is generally made equal to, sometimes a little greater than, the thickness of the cylinder. The dimensions of ports depend on the speed at which the engine has to run, and this data you do not give us, we therefore cannot give you the size of ports. The answer to Question 514 will enable you to determine the size of ports, which you will see is a simple matter.

(523) A. B., ———, writes: I wish to harden liners for dry press brick machine moulds. They are 5 in. x 6 in., and 9 in. x 6 in., ⅛ inch thick, and of the best English saw steel The small sizes have four 5-16 in. holes, through them, and the larger ones have 6 holes. They are riveted to their places. The trouble is, they crack or spring, and I would like to know how to avoid this. *A.*—The cracking is probably caused by too high, or uneven heat; and the springing may be from the same cause; though it is usually not possible to entirely avoid springing in such pieces; but if they are required to be straight they must be hammered straight after tempering: though, of course, this cannot be done if they are to be tempered much harder than ordinary saws.

(524) Subscriber, Auburn, N. Y., writes: We have a 300 horse-power compound condensing engine and a Blake condensing pump. The suction pipe is 6 inches diameter, made of cast-iron, it is well painted, and we suppose good joints, length 300 feet, with about 20 feet rise; it draws water from our water wheel flume, where the current is not the steadiest, although the foot valve is 3 to 4 feet under water all the time. Now, 1. What amount of air would the suction pipe, full of water, be apt to contain, and how many inches of vacuum would we be likely to lose from this cause, pump running 60 strokes per minute? *A.*—Under the given conditions, the suction pipe will, practically, not contain any air, and therefore cannot affect the vacuum to any appreciable extent. 2. Would we get more air through the 300 feet of suction pipe than through a 25 feet suction pipe, provided both are practically air-tight? *A.*—No.

(525) A. U. G., Cleburne, Texas, writes: I have a pump which is 6″ water cylinder, 12″ stroke, suction pipe 1,400 feet long, consisting of 600 feet 4″ pipe, 500 feet 3½″ pipe, and 300 feet of 3″ pipe. This pump cannot be run faster than 25 strokes a minute without producing a severe jar. At this speed very little water is pumped. To help matters, I propose to place upon the suction pipe, near the pump, an air chamber made of 5-inch pipe 10 feet long. My theory is that this air chamber will fill with water and act as a reservoir to supply water end of pump, thus enabling pump to be run faster and pump more water in a given time, at the same time lessening the shock. Am I correct? What would you suggest as the best and cheapest remedy for the existing evil? *A.*—An air chamber as near the pump as possible is the proper remedy. In all cases where suction pipes are long an air chamber should be employed. Its use is to cushion the blow and make the flow more uniform. But it should not entirely fill with water.

(526) P. G. R., Marshall, Texas, asks for information about tempering spring washers which are made of good crucible cast-steel ⅛ inch thick and 1¾ inch square. What is the best way to temper them in large quantities? Is there any successful way of tempering them in one operation by dipping, provided they are heated uniformly? *A.*—They may be heated rapidly in a lead bath and afterwards drawn in oil. Or, they may be heated in iron boxes placed in a furnace. As you are likely to use large numbers of these pieces, we should advise you to consult with the makers of the steel regarding the matter. 2. Suppose we harden them in oil and they enter the oil at a cherry red, what temperature will it require to draw them just right, using lard oil? *A.*—It depends upon the "temper" of the steel originally, and it can best be determined by a few practical tests, using a thermometer. You can, we think, procure steel which will require no "drawing" after the quenching. 3. What are the boiling and flaming temperatures of the different oils suitable for tempering? *A.*—We have no data upon this point.

(527) J. H.., Milwaukee, Wis., writes: Our engine was originally a 28″ × 48″ condensing engine, with Reynolds' Corliss valve gear. It has now been made into a tandem compound, by adding a 16-inch cylinder, so that now we have an engine 16″, 28″ × 48″ stroke. The cylinders are placed as close together as possible, leaving only sufficient room for the stuffing boxes, thereby obtaining the least amount of piping to get the steam from high to low-pressure cylinder. The exhaust pipe from the high-pressure cylinder used to be 6 inches in diameter; it is now 8 inches diameter. This exhaust pipe forms the receiver. Now I wish to ask you: Is this receiver large enough to give the best results? *A.*—Generally, in tandem compound engines, such a large receiver is not required as is needed in engines in which the cylinders stand side by side, and cranks at right-angles, because in the former the exhaust from high-pressure cylinder flows almost directly into the L. P. cylinder, and does not need to be stored up, as in the latter class of engines, until the L. P. cylinder is ready to take it. The minimum capacity of the receiver for tandem engines will depend upon the arrangement of the cut-off, and this you have not given. The fact that the designer increased the diameter of the exhaust pipe from high-pressure cylinders indicates to us that he knew the importance of a receiver, and that it will be large enough.

(528) E. I. W., San Jose, Cal., writes: Will you kindly inform us how many cubic feet a flume constructed as per sketch will discharge per second? Also give formula to proportion a flume for any given quantity of water. *A.*—The following formula will give the discharge per minute:

$$C = \left(\frac{874520 \times F \times A}{L \times P}\right)^{\frac{1}{2}} \times A$$

In which L = length of channel in yards.

A = cross-sectional area of the steam in square feet.

P = the perimeter, or wetted border in feet.

F = the fall, or difference of level at the two ends of the channel in inches.

C = cubic feet discharged per minute.

According to the sketch

$L = 5.3$ yards.

$A = 4.5$ square feet.

$P = 6$ feet.

$F = 1$ inch.

Hence, per formula we have

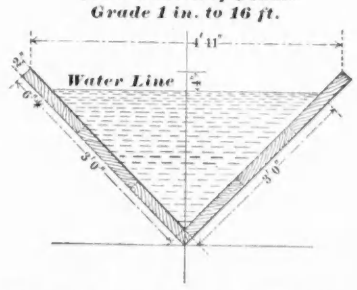
$$\left(\frac{874520 \times 1 \times 4.5}{5.3 \times 6}\right)^{\frac{1}{2}} \times 4.5 = 1582.6$$

cubic feet discharged per minute, and

$$\frac{1582.6}{60} = 263.7 \text{ cubic feet}$$

discharged per second. From the foregoing formula you can construct other formulas to aid you in designing flumes. For further information see Practical Hydraulics, by Thomas Box, from which this formula has been taken.

Cross Section of Flume
Grade 1 in. to 16 ft.



(529) T. B., Cleveland,· O., asks: Why is power derived from a common block and tackle, and this power increased with the number of wheels? *A.*—Of course you mean the force, instead of the power. If you suspend a rope from a fixed point, and to the other end fix a weight, it is evident that the rope will bear the strain of all the weight, but if, instead of attaching the rope directly to the weight, you pass it around a pulley and carry the other end up and fasten it, the weight will be supported by what is virtually two ropes, each of which bears one-half the load. If you now take hold of one of these ropes and pull it upwards until the part above your hand is slack, it is evident that you would be supporting only half the weight; and if you drew the rope upwards you would need to pull only half the weight, plus the friction of the pulley and the resistance caused by the stiffness of the rope. Now if, instead of pulling directly upwards, you passed the rope over a fixed pulley and pulled downwards, it would be the same thing, only that the friction of the additional pulley would be added. Now, if you have a second pulley on the weight, and pass your end of the rope around this pulley and again pull upwards, the weight will be supported by four parts of the rope, only one of which you will be holding. Consequently you can raise the rope by pulling upwards with a force equal to one-fourth of the weight, plus the friction and resistance due to the stiffness of the rope. In each case the distance moved by the weight will be equal to that fraction of the distance moved by your hand, found by dividing unity by the number of parts of the rope supporting the weight. This explains why it is that *force* (not power) is increased by a block and tackle, and by each increase in the number of movable pulleys.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p. 16.

Link Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

Fuel oil burners. A. E. Jenkins, Scranton, Pa.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight Feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

"How to Keep Boilers Clean." A 96 page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st, N.Y.

R. Dudgeon, 24 Columbia st., New York Improved Hydraulic Jacks and Roller Tube Expanders.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st. Chicago, Ill.

Patents—Whittlesey & Wright, 705 8th st., N W. Washington D.C. Send for pamphlet and references

Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

The Waterhouse Arc Light for Factories is entirely satisfactory. The Waterhouse Electric and Manufacturing Co., Hartford, Ct.

Upright drills, improved, sizes 21″, 23″, 25″, 28″, 32″, 36″ swing: finely made and great capacity. Currier & Snyder, Worcester, Mass.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

See illustration of improvements in Hooks for Steam Engines, in Nov. 24 issue. For particulars address T. C. Dill Machine Co., 726 Girard av., Phila., Pa.

Machinists' supplies, brass goods, m'f'rs supplies, polishing materials all kinds wire, metals, etc., in any quantity Jordan & Gottfried, 208 Canal st., N.Y.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st, N Y City.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Dec. 1, p 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

Patents—Gov't and atty's fees refunded upon failure to obtain patent after favorable report by me. R G. DuBois, expert in patents, 928 F street, Washington, D. C.

With my System, Exhaust Steam Heating costs nothing for fuel; Live Steam Apparatus altered to Exhaust Satisfaction guaranteed. Geo. A. Barnard, 15 Cortlandt street, New York.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.

A system of easy lettering by J. H. Cromwell, giving 26 forms of alphabets. The space to be lettered being divided into squares; simple and effective. Price 50 cents. Catalogue of books for engineers free. E. & F. N. Spon, 12 Cortlandt st, N.Y.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st, New York.

"Practical Drawing." By J. G. A. Meyer. The above series of articles now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including Nov. 3, 1888 issue, 62 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 76 articles have thus far appeared up to and including the Oct. 27, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York

MANUFACTURES.

E. T. Hartwell is building a steam mill at Oldtown, Me.

George Shultz will build a machine shop at Cleveland, Tenn.

George Moore will build a sash, door and bind factory at Nashville, Tenn.

The Bluffton Iron Ore Company propose building a furnace at Bluffton, Ala.

The Trion Manufacturing Co. have begun work on a cotton factory at Trion, Ga.

The Hill Friction Pulley Co., of Cleveland, O., are increasing the capacity of their works.

The Chattanooga (Tenn.) Plow Works are enlarging their foundry by adding an addition, 60x90 feet, of brick and stone. They regard the outlook as very encouraging.

The Iron City Manufacturing Company is the name of the firm at Pittsburgh, Pa., that succeeds to the business of Geo. Y. McMurty, in the manufacture of hot pressed nuts.

Fred Sloss has purchased the Baxter Stove Works, at Birmingham, Ala., and will build at once a 60-ton furnace. He already has a rolling mill, and will build another for making structural iron.

The Thomson Electric Welding Company, Boston, Mass., have issued an interesting catalogue descriptive of the processes of electric welding. The company build and sell welding machines.

The foundry of the Rowland Plow Co., at Baltimore, Md., recently burned, will be rebuilt at once.

McLaury, Underwood & Scott, whose sugar house and refinery, at Franklin, La., was recently burned, will rebuild at once.

The Waterhouse Arc System of electric lighting is now controlled by Mr. George Westinghouse, Jr., Pittsburgh. Mr. Westinghouse also controls the Sawyer-Mann Electric Co., the Consolidated Electric Light Co., and the Westinghouse Electric Co.

Hill Brothers, of Canaan, are pushing forward their big wood-working manufactory at Harmony, Me. A portable mill has been set up, and the main factory, 100x40, will be built this fall. During the winter a saw mill will be built, and next spring the plant will be still further increased.

The Volker & Felthousen Mfg. Co., Buffalo. N. Y., write us: We have received the contract for two duplex compound condensing engines for Greenville, Texas. The engines are to be center packed, condenser to be attached to engines. Each engine is to have a capacity of 1,000,000 gallons per day.

A notice has been posted at the Warren foundry, at Phillipsburg, N. J., the largest establishment in the town, and employing 400 men, that all the single men would be suspended and the married men retained. It was also stated that there was danger of the largest of the company's shops being shut down.

Sweet's Mfg. Co., Syracuse, N. Y., have decided to discontinue the manufacture of wire nails, their increasing merchant steel trade requiring all the time and space at their command. The wire nail plant will be sold entire. There are 25 new nail machines, built under the personal supervision of W. A. Sweet.

We have received from the Cowles Electrical Smelting and Aluminum Co., of Lockport, N. Y., a pamphlet relating to the alloys of aluminum and silicon produced by them in the Cowles Electrical Furnace. The pamphlet contains a good deal of useful information relating to the production, use and strength of these alloys.

James E. Hotchkiss, 120 Liberty street, New York, has issued a new edition of his little book, "How to Keep Boilers Clean." Although it is in the nature of a trade catalogue—and as such sent free—it contains matter of general interest to engineers. A new departure is in the way of several pages of terse quotations from eminent writers.

An Ishpeming, Mich., dispatch, says: The Cleveland Iron Mining Company has raised the wages of its employes, and the Chicago and Manhattan Railway has increased the pay of the men on construction work. The Calumet and Hecla copper mine will also raise wages soon. The prospect is good for a general increase of wages for skilled and unskilled labor in the iron and copper mining regions.

The Gage Tool Company, Vineland, N. J., have been doing a steadily increasing business in their self-setting planes, and this has brought about the necessity for better facilities for manufacturing, which enables them to manufacture at less cost. They are sending a good many planes to foreign countries, as England, Germany, Italy, South America, Mexico and Australia. Prospects for a large export trade are good.

The Tanite Co., Stroudsburg, Pa., are offering to the trade solid emery oil stones, and knife sharpeners, made in a superior manner. The oil stones are made in two grades, one for putting a rough edge on tools, and the other for a fine edge. The knife sharpener is a wooden stick, triple coated with emery, and is recommended for sharpening kitchen-knives, carving-knives, sickles, lawn-mower knives, and other cutting instruments.

The foundry and machine department of the Harrisburg (Pa.) Car Manufacturing Co. are very busy on engine and boiler work, gas plants, oil tanks, etc. Their orders for the Ide engine have been large during the past six weeks. Most of the boilers sold have been set with the Weitmyer furnace, controlled by this company. They have also reset many boilers with this setting. The company are also busy on large engines and saw mills for portable work.

The Missouri Malleable Iron Company are equipping a machine-shop at their works, on Twenty-first and Papin street [St. Louis], to do light work. It will occupy a second-story floor, where abundant room and light are available, and will enable them to finish their castings themselves, and contract, to some extent, for outside work in the same line. A visit to the new department which Superintendent Taggert says will be running by the first of next month, showed that a good deal of the necessary machinery was on hand and in position. Among the new tools noticed were 17 and 27-inch Lodge-Davis lathes, 28-inch Bickford drill, 24 by 24-inch 6-foot Powell planer, small drill presses, chucks, etc.—*The Age of Steel.*

The Newburyport [Mass.] Car Manufacturing Co. are turning out an order of twenty electric street cars for the West End Street Railway Co., of Boston. Of these, eight have been delivered, four go this week and the balance go shortly. They are all for the new Beacon Street line to Brookline, and will soon be running, by electricity. Work at these car shops is very brisk. Four electric cars are being built for the Thomson-Houston Co., two for the Newburyport and Amesbury Railroad, to run between Amesbury and Merrimac; some for the Bangor Electric Railway, and an order of horse cars for the Nashua Horse Railroad. Work will soon be commenced on open horse cars for next season.—*The Commercial Bulletin.*

Machinists' Supplies and Iron.

NEW YORK, Nov. 22, 1888.

Iron—American Pig—No change of importance has taken place since our last report, and the schedules for 1889 deliveries have not yet been announced. We quote Standard Lehigh and North River brands at $18 to $19 for No. 1 X Foundry, and $17 to $17.50; Grey Forge, $15.50 to $16.25.

Scotch Pig—We quote Coltness, $21.50; Gartsherrie, $21; Summerlee, $21.75; Eglinton, $19.25 to $19.50; Dalmellington, $20.25; Clyde, $20.50; Langloan, $20.50.

Copper—The French combination has complete control both here and in Europe, and quotations are without special significance. Lake is quoted at 17½c.; casting brands, 16 to 16½c.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—See bottom of third column, page 11.

A competent draftsman desires to make a change in New York or Brooklyn. BOX 46, AM. MACHINIST.

Wanted—A salesman who has had experience in selling machinery. Address BOX 47, AM. MACHINIST.

Wanted—By practical pattern maker and draftsman, position as foreman pattern maker. S. K., AMERICAN MACHINIST.

Wanted—First-class pattern maker. Steady work and good pay to the right man. Davenport Foundry and Machine Co., Davenport, Iowa.

Wanted—Three first-class toolmakers, accustomed to making dies and tools for small trap articles. Address Ottumwa Iron Works, Ottumwa, Iowa.

Wanted—Foreman for machine shop employing about 50 men, doing a general manufacturing and jobbing business. State age, what experience, and full particulars. Sulzer and Vogt, Louisville, Ky.

Wanted at once.—A first class machinist to take charge of and take a cash interest in a machine shop doing a fine manufacturing and repair business in a prosperous city in northern Wisconsin. Address box 45, AMERICAN MACHINIST.

Situation wanted by a Connecticut Yankee, 39 years old, with 15 years' railroad experience in machine shops and on road, 4 years' technical newspaper, 2 years' model making, and 5 years superintendent and erecting electric light plants. Address F. L., AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Gerlach's Engineers' specialties beat the world. Send for price list. Crescent Mfg. Co., Cleveland, O.

Crescent grease cup for shafting beats them all. Sample free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

August C. Christensen, 24 State st., N. Y., consulting engineer for hydr. and pumping machinery, etc.

Working drawings for machinery. D. J. Kelsey, M. E., 32 Ins. Bld., New Haven, Ct.

Correspondence solicited with parties having machine or foundry specialties to build. Honesdale Iron Works, Honesdale, Pa.

Wanted.—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati O.

For Sale, Cheap—A complete wire nail plant, consisting of 25 machines of the most modern construction, tumbling barrels, reels, etc. Address Sweet's Manufacturing Co., Syracuse, N. Y.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For Sale—Machine Shop and Foundry, at a bargain, in Western Ohio; business profitable; can give satisfactory reasons for selling. Address M., care AMERICAN MACHINIST.

In stock and for sale, a large lot of new and second-hand engine lathes, iron planers, upright drills, shaping machines and other machine tools. Send for list and catalogue. Address Fitchburg Machine Works, manufacturers of metal working machinery, Fitchburg, Mass.

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CONSULTING ENGINEER, 149 B'way, N. Y.
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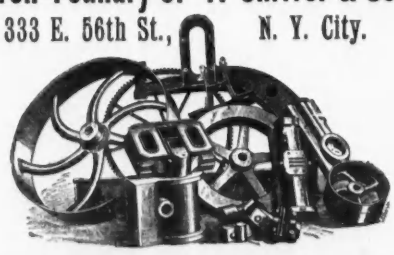

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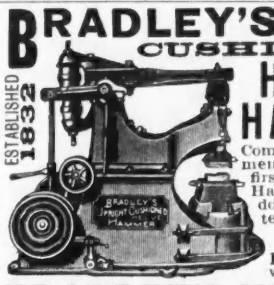

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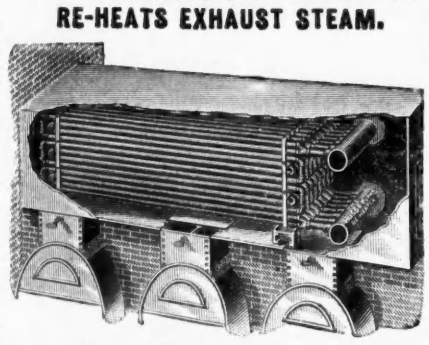

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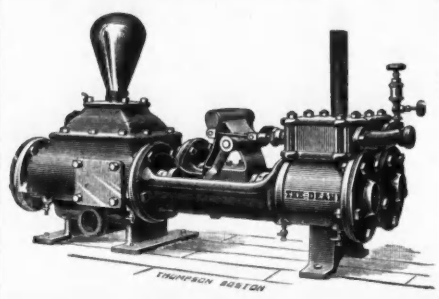

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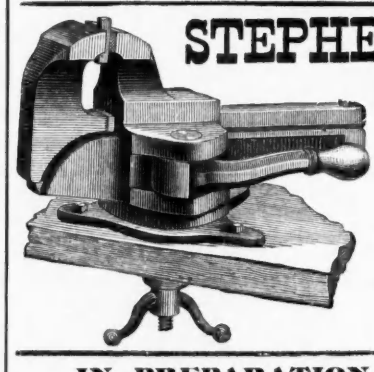

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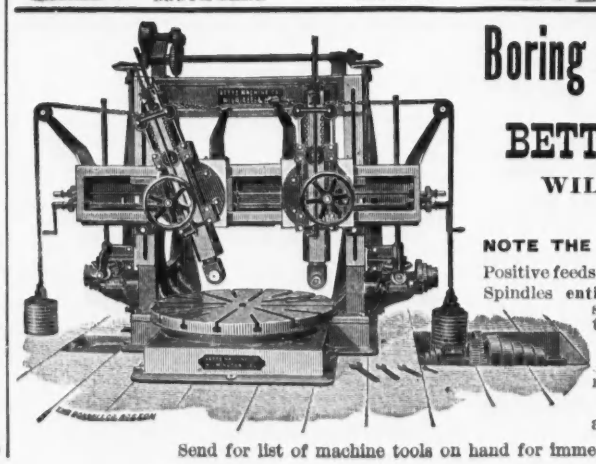

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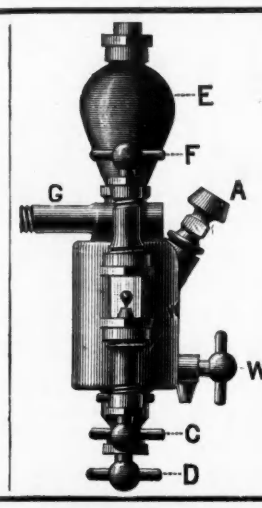

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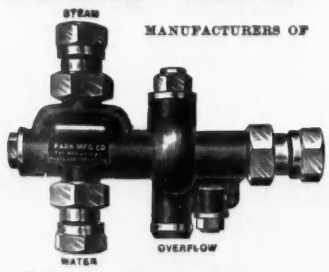

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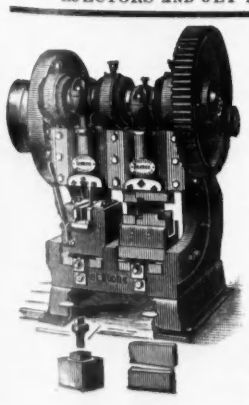

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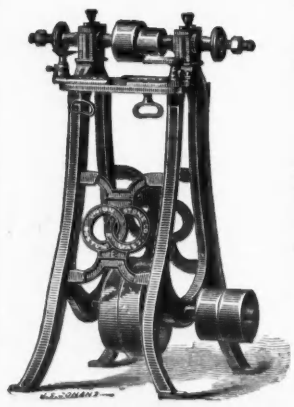

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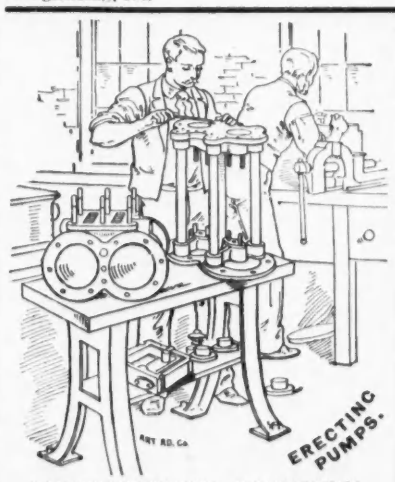

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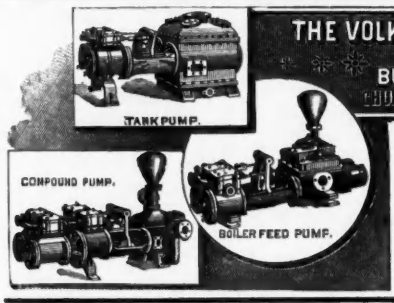

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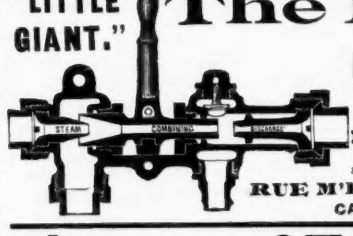

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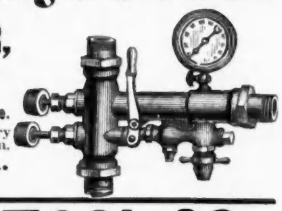

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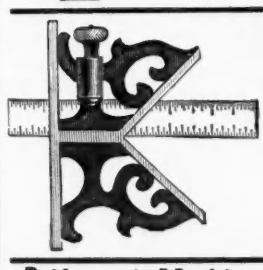

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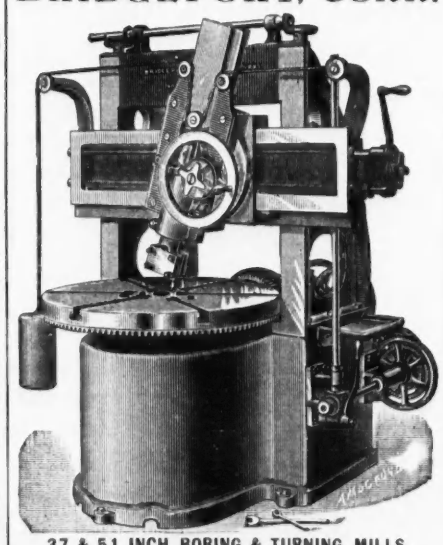

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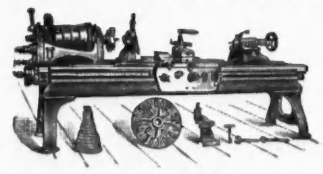

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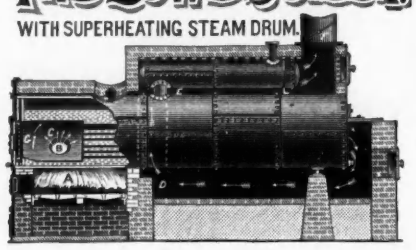

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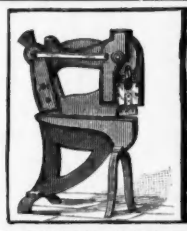

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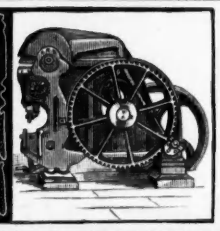

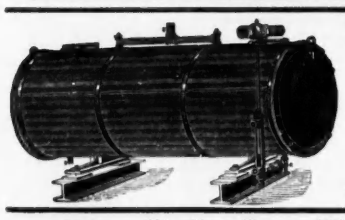

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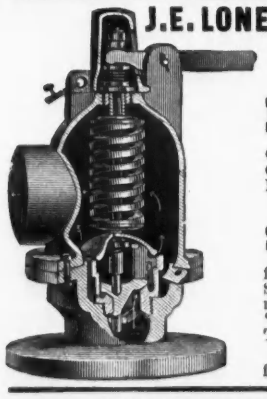

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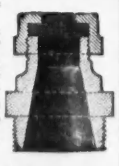

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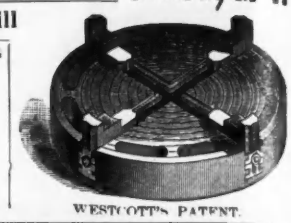

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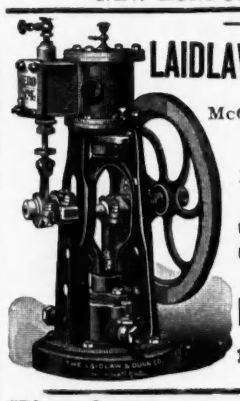

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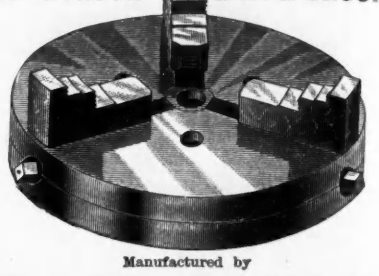

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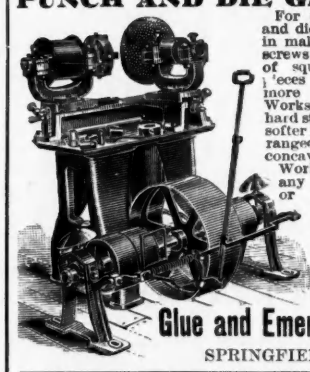

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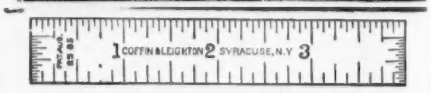

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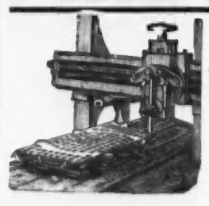

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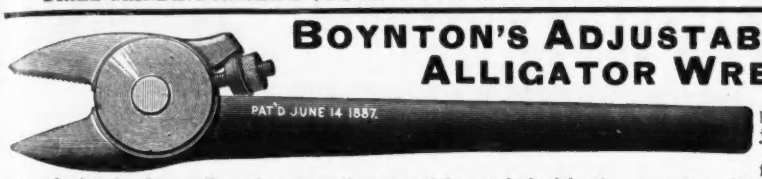

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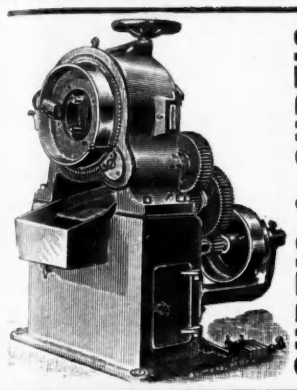

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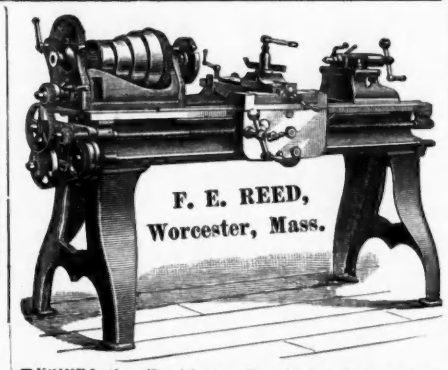

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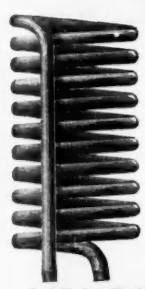

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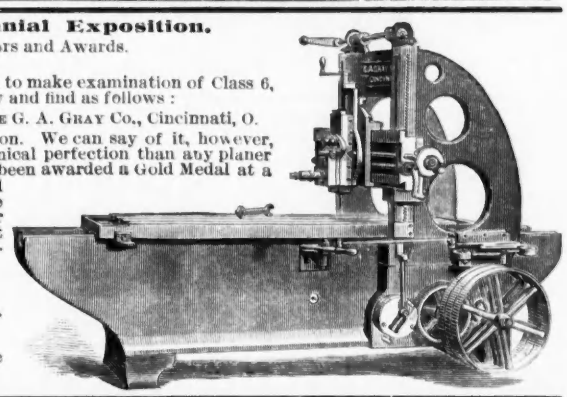
This machine has no competition. We can say of it, however, that it approaches nearer to mechanical perfection than any planer we have ever examined. As it has been awarded a Gold Medal at a former Exposition (Cincinnati,) and as the highest award we could make under the rules would be a Silver Medal, we do not wish to detract from its Golden Record, and therefore make no award.

D. D. MARTIN,
WM. CORRY,
M. L. ANDREW. } *Jurors.*

The Board of Commissioners have awarded a Silver Medal.



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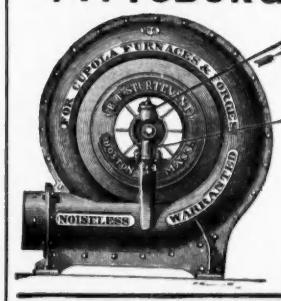

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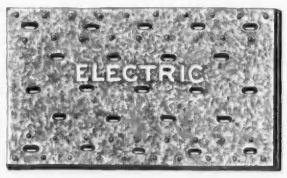

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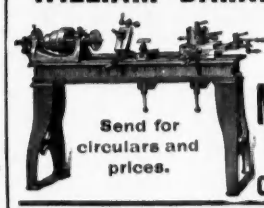

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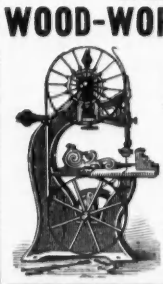

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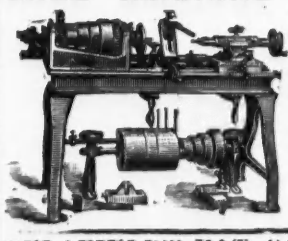

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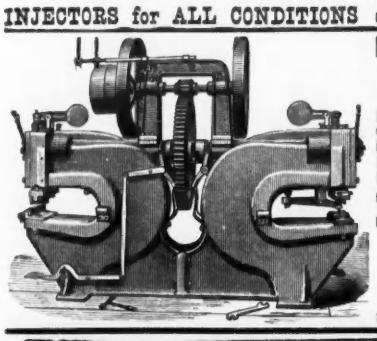

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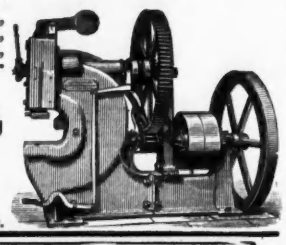

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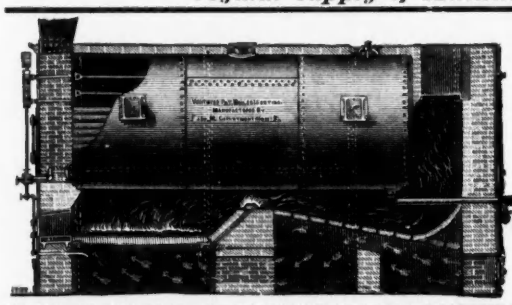

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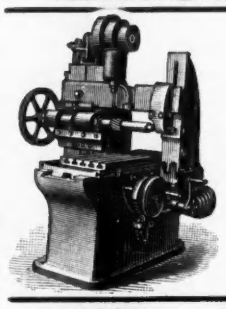

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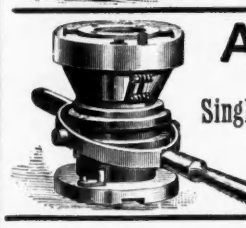

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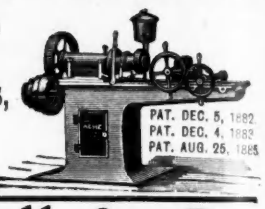

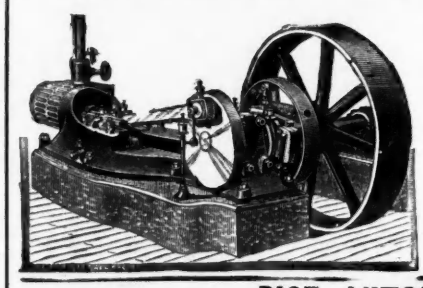

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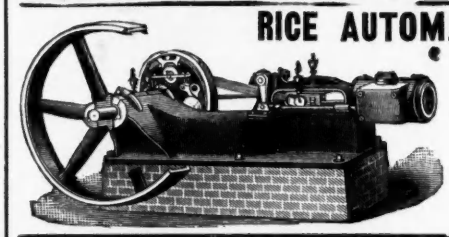

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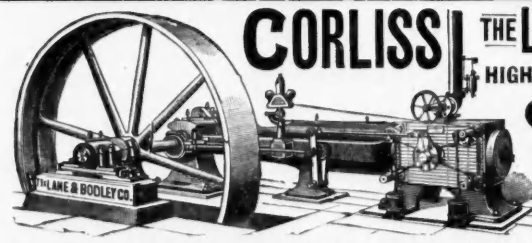

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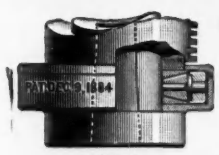

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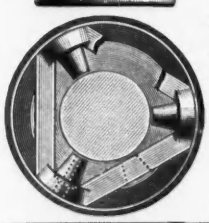

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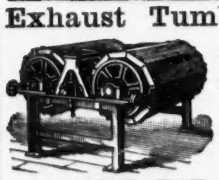

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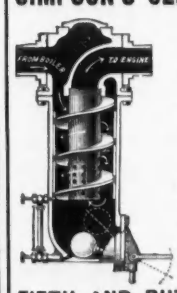

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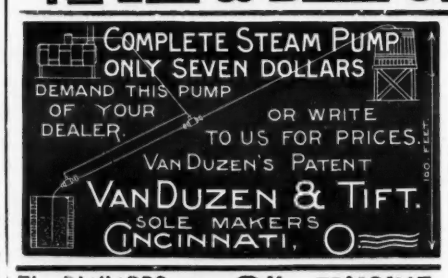

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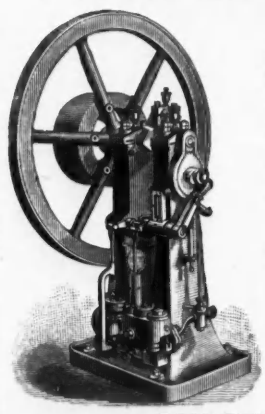

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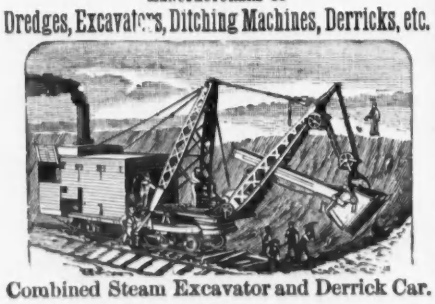

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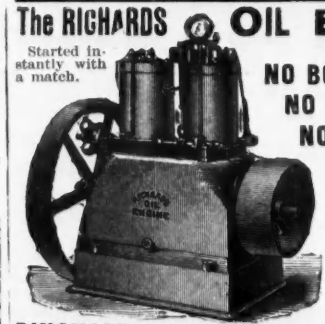

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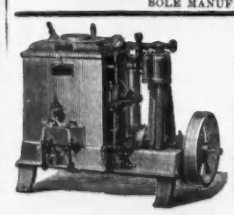

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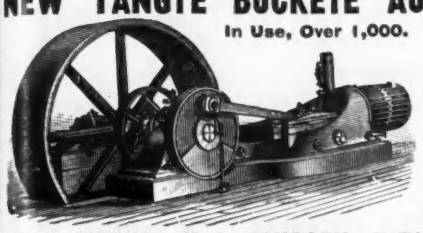

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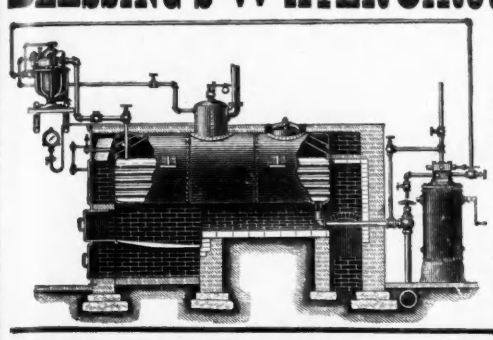

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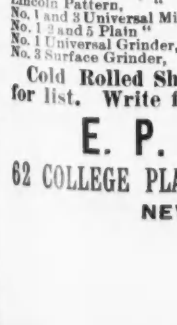

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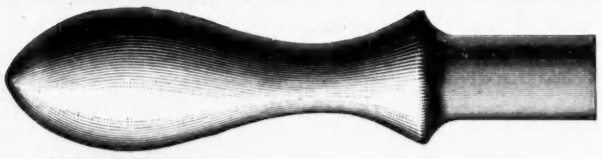

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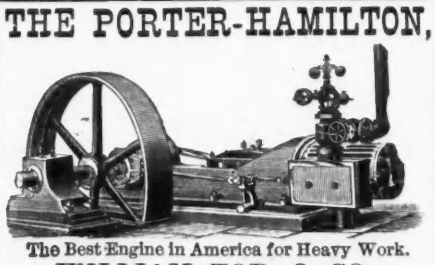

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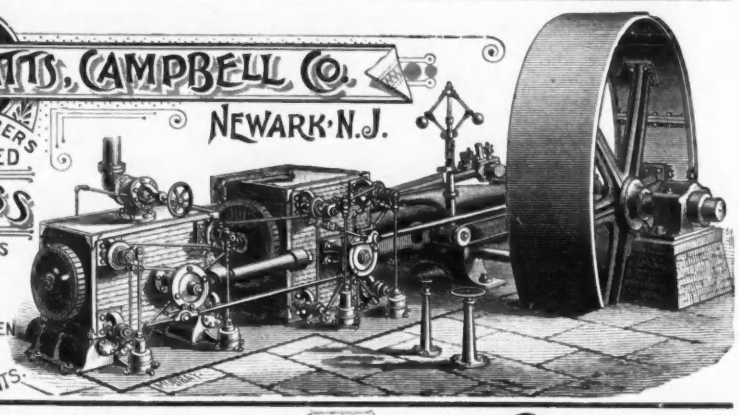

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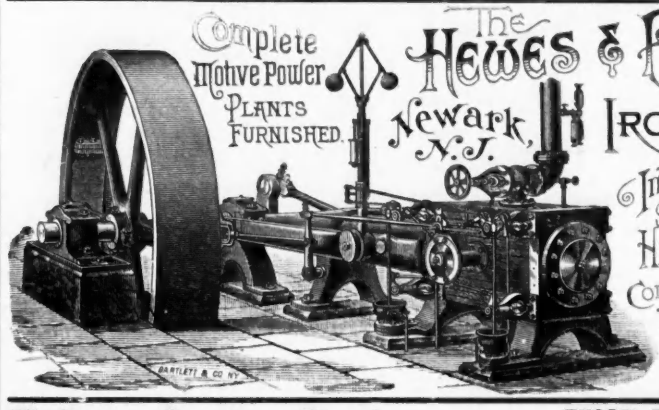

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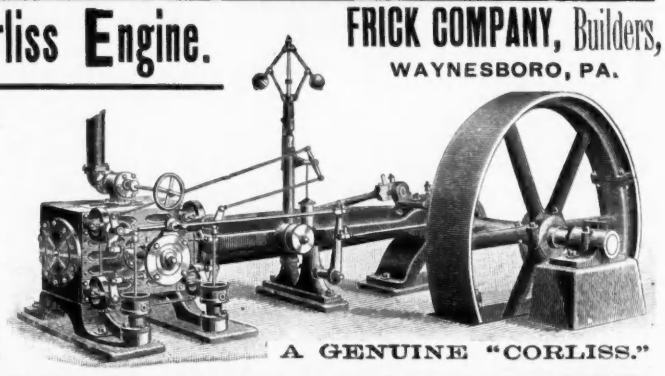

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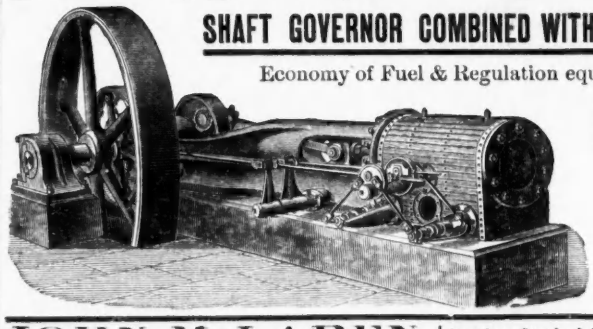

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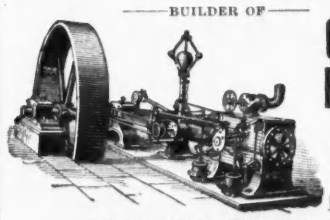

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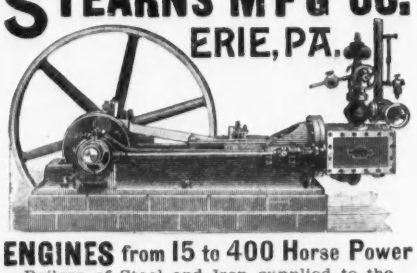

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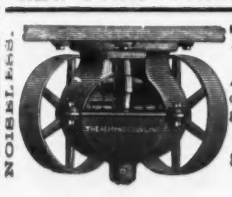

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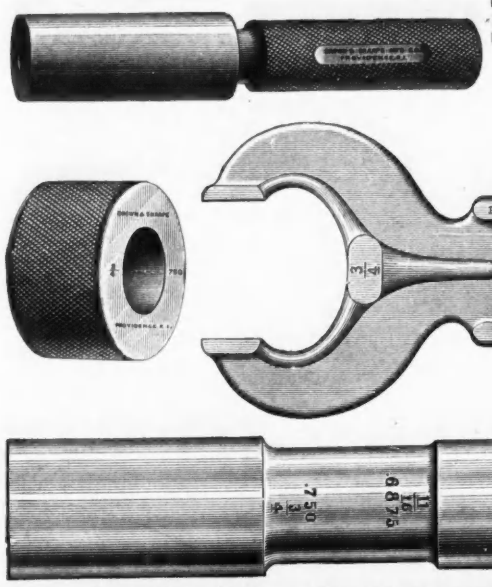

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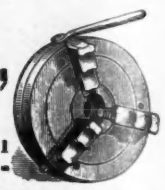
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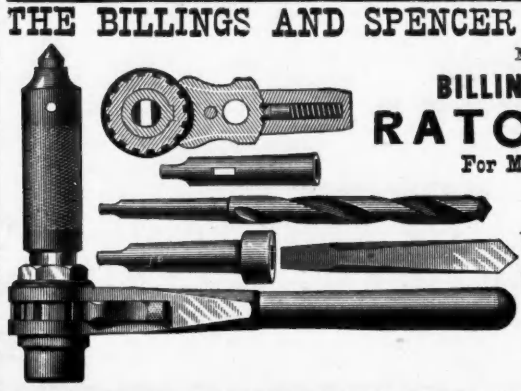
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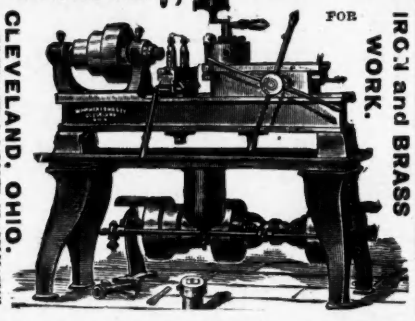
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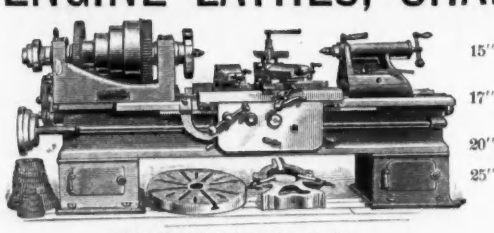
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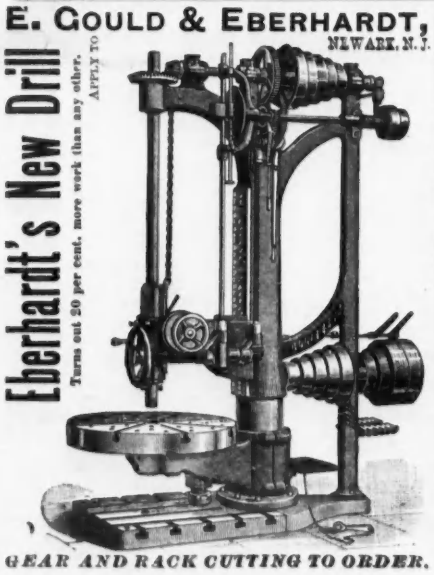
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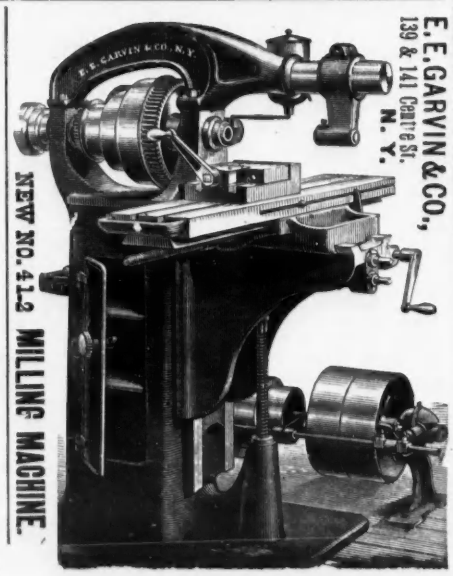
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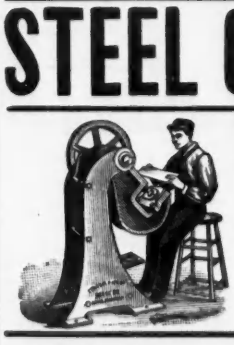
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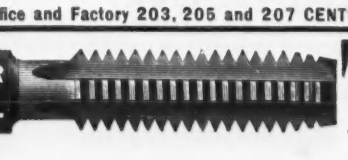
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